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A
GEOLOGICAL SKETCH
OF
THE VICINITY
OF
HASTINGS.

By WILLIAM HENRY FITTON,
M.D., V.P.G.S., F.R.S.

LONDON:
PRINTED FOR
LONGMAN, REES, ORME, BROWN, GREEN, AND LONGMAN;
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1833.

Printed by Richard Taylor, Red Lion Court, Fleet Street.

THE following pages were drawn up at the request of some near relatives of the author who reside at Hastings, and printed to form a part of a new edition of Wool's 'GUIDE TO HASTINGS AND ST. LEONARD'S;' but having been insensibly extended to a greater length than seemed to be adapted to that Work, it has been thought better to publish them apart.

This explanation will account for the form and style of the present little volume,—for the omission of some topics, and the very brief discussion of others,—which, under different circumstances, would have been treated of more fully.

W. H. F.

London, December 1832.

ERRATA.

In the wood-cuts, at pages 2 and 8, the upper stratum, marked '1, 2,' is intended to denote,—1, The *Chalk*; and 2, The *Upper Green-sand*, into which the chalk passes insensibly at the lower part.

Page 11, Note, *for* 'M. de la Beche' *read* 'Mr. De la Beche.'

—— 19, line 13, *for* '3' *read* '2'.

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GEOLOGICAL SKETCH

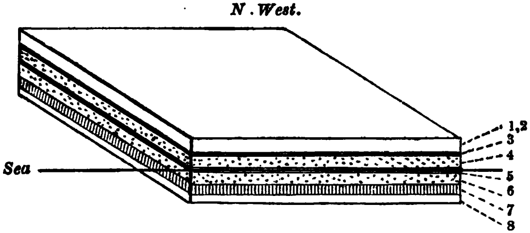
OF

THE VICINITY OF HASTINGS.

(1.) The Country about to be described affords a remarkable proof of the recent progress of Geology, in England. About twelve years ago (in 1821) the writer of these pages being about to visit Hastings, was informed that there was nothing there of any interest; that the whole was merely "Iron-sand," with few or none of those appearances which so well repay the close examination of other districts. It is now known, on the contrary, that the range of varied country included by the Chalk Downs of Kent, Surrey, Hants, and Sussex, and of which Hastings may be considered as the middle point, is one of the most interesting Geological tracts in England; that it is the depository of some most curious and peculiar organized remains, and affords some of the best evidence hitherto obtained, respecting the great and astonishing changes which have taken place upon the surface of the globe.

That our readers may understand this, it will be expedient to say a few words on the general structure of the south-east coast, of which the vicinity of Hastings is a portion.

(2.) All this part of England—indeed, by much the greater part of all the British Isles—is stratified, or formed of layers, of stone, clay, sand, &c. placed one above another with great uniformity, and in general not much inclined to the horizon. A ream of paper, or a pile of pasteboard, will serve to illustrate its structure and arrangement; or a pile of pieces of cloth, of different colours and unequal thicknesses, will answer better, since it may be bent into curves and inequalities, as the strata of the earth really have been. For simplicity, we shall suppose that the layers of our pile are few in number, though in nature the strata are very numerous; each piece of the cloth may stand for a group of several thinner strata; and the following figure of such a pile will then serve to represent a small portion, cut out, as it were, from the coast of Kent and Sussex.



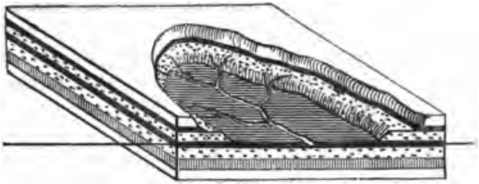
If the dark line across the lower part of this figure represent the level of the sea, and the furthest corner of the pile be supposed to be raised a little to the north-west, it will express, pretty well, the general disposition of the strata: and that portion of the end of our pile which is above the dark line, will be a cliff composed of four strata, or groups of strata, with a part of a fifth.

(3.) If this position of the beds were undisturbed, and the materials of the strata indestructible, it is obvious that a Geologist in going along the shore would find everywhere the same appearances; and that if he mounted to the top of the cliff, and travelled in any direction, inland from the sea, he would run continually upon the uppermost stratum of the group, or the piece of cloth, No. 1.

(4.) But the materials of the globe, so far from being indestructible, are constantly worn away by the action of the elements; they are loosened by frosts and rain; and small detached portions are continually carried off by water. The effect of torrents and rivulets, which cut into the beds with never-ceasing activity, is to form channels and valleys, which go on widening and descending, till the waters gain free access to the sea. We shall find, also, reason to believe that the strata have been, in some cases, broken up, by forces of still greater vehemence acting from below.

(5.) But, farther, a very great proportion of the earth's surface, and nearly the whole of that part of England which now occupies our attention, bears the most incontestible evidence of having been deposited under water; of having been, at one time, not only submerged by the sea, but *gradually* accumulated at its bottom. Nearly all the strata contain the remains of shells in great profusion, the bones and scales of fishes, fragments or entire trunks of timber, fragments also of stone, very commonly in the form of pebbles, evidently worn and rounded by friction under water. It will be readily allowed that if a series of beds were thus accumulated at the bottom of the sea, the tides or other currents might break up and wear away the matter first deposited, long before its elevation out of the water,—or, which would have the same effect, before the subsidence of the water had allowed the land to appear.

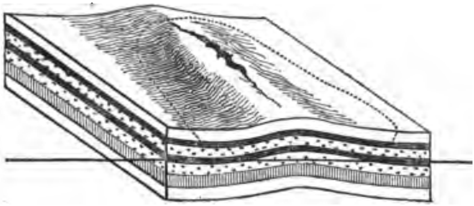
(6.) Let us suppose, then, a tract of stratified land to have been thus elevated, or left by the water; and the beds,—either from previous wearing, or the subsequent effects of exposure, or from both these causes, to be partially carried away,—the result would be, the formation of a valley, such as is represented in the figure at page 5: so that a traveller along the shore would find a chasm at the entrance of the valley; in ascending along it, he would first pass over the surface of the lowest bed unveiled by the wearing agents; and if he wished to reach the top of the sides, he would everywhere have to pass successively over the same strata, in the same order. If the beds (or layers of the pile) differed, as they commonly do, in firmness and destructibility, the more solid amongst them would form steps or projections; and at last, the sides of the valley would come to be somewhat like the inside of a great amphitheatre, with seats on all sides, rising one above another.



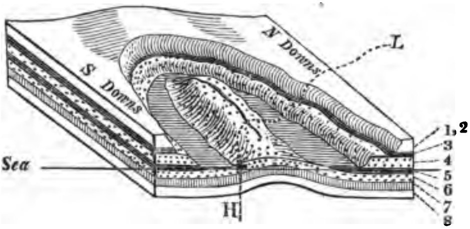
(7.) Examples of such vallies as this figure represents, are to be seen in every stratified country. They are technically called vallies of *Denudation*, from the denuding process by which they are produced. The deep ravine by which the main road from London enters Hastings is such a valley; the strata on the opposite sides corresponding, or being, in fact, portions of the same beds; and a heap of great roundish masses of stone which lay upon the shore, just opposite to this excavation, a few years ago, was probably derived from the fall and ruin of the upper beds in the face of the cliff, which formerly occupied this chasm. The vallies which open to the shore at the Lover's Seat, that of Eaglesbourne, &c., are also good examples of this kind of structure.

(8.) But the beds, or groups of strata, in England, do not retain the position in which we must suppose them to have been deposited. Besides being raised, generally and uniformly, a little towards the west of north, they have, in some places, (and the country near Hastings is an example,) been forced upwards, by local and irregular action of great violence. Where the beds have not been absolutely cracked and fissured by these operations, they are curved into waves and inequalities, which, although quite insignificant in comparison with the great extent of the globe, are of great practical importance to us, the diminutive inhabitants of its surface. In some cases, the beds appear to have been burst or thrust outwards by direct explosive power; in others, it would seem that, after having been deposited horizontally over previous irregularities at the bottom of the sea, they had been forced upwards, cracked and shattered, by the upheaving of the solid masses beneath them.

(9.) Now if the pile of cloths represented at page 2, were pressed upwards, in a direction nearly parallel to its sides, by a blunt instrument or a mass of irregular outline, or by a force of great inequality at different points of its action, the effect would be the production of a ridge or crack, such as we have just described; and the result would probably be rendered less uniform, if the substances acted upon were very different in firmness and cohesion. So that, in some places, only a wave or bending would be produced, in others the strata would be broken entirely through, and the separated edges of the fissure probably be detached from each other, in proportion to the force and direction of the effort.



As the whole of the upheaved portion of the strata would be more or less disturbed, the effects upon them, of the ordinary wearing agents, would be rendered more easy and rapid; the degree of destruction thus produced would also be proportioned to their tenacity or power of resistance; and when the loosened materials were carried off, either beneath the sea, before the elevation of the land, or more gradually after it had been uncovered, the result, at last, would be the formation of a valley like that represented in the following page;—more complex than that of page 5, but which will be easily understood by combining that figure with that which the reader has now before him, and imagining the causes which produced the valley to have acted with varying degrees of force within the circuit marked out by the dotted line on the upper surface of the figure in this page. For the bed No. 6, if supposed to have much greater solidity or toughness than those above it, would withstand the denuding causes which had removed them, and at last, would project in the middle of the denudation, like an insulated ridge, surrounded on the inland side by a crescent-shaped valley, produced and maintained by the continued effects of ordinary decay upon the more destructible beds, in the superior portion of our pile *.



(10.) Now this is precisely the structure of the great vale, of which the north and south Chalk Downs form the boundaries. The ridge between the Downs is the *Forest-Ridge*, which extends from the sea to beyond Horsham, in Sussex, and of which the central point upon the shore is at no great distance from Hastings; the heights of

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* The results of this process are technically called *Valleys of Elevation*; not that denudation, also, has not had the principal share in their production, as well as in that of the valley represented at page 5, but that the previous *elevation* of the strata in a wave or ridge, has been the cause of their peculiar form.

Ashdown Forest and Crowborough Beacon being the points of its greatest elevation. The ridge, it will be seen, is nearly surrounded by the Wealds of Kent, Surrey, Hampshire, and Sussex, and cut off by the sea on the south-east. And if we suppose the strong line (marked *Sea*) to represent the average level of the water in the English Channel, the part of the pile above that line in the figure, will be a tolerable epitome of the real aspect of the coast, from the chalk cliffs of Beachy Head to those of Folkstone Hill, of which another view in more just proportions is given in the annexed plate, figure 2. But to convert the section presented by the pile of cloth, into such a figure as that of the engraving, we must suppose the former to be elastic, and to be pulled out, to more than eight times its present length. Even then it has been necessary that the height of the cliffs should be greatly exaggerated in the engraving, in proportion to their horizontal extent: for on the scale of figure 2,* a cliff of three hundred feet would be less than one hundredth of an inch in height; and Beachy Head, which is about five hundred and fifty feet high, would be reduced to the present height of Bexhill on the section, so that the height of the lower points would hardly be distinguishable, if correctly represented according to the scale.

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* The scale of this section, in the plate, is about six miles (of 1760 yards or 5280 feet) to an inch.

One inch, therefore, is equal (nearly) to 31,700 feet
One tenth of an inch . . . . to 3,170 feet
One hundredth . . . . to 317 feet.

(11.) Again, if we suppose that Hastings is placed upon the coast within that stratum which is numbered 6, and the point L, without the pile, to stand for London; the dotted line from L to H will be the road to Hastings, of which a more detailed section is given in figure 1 of the plate; and it will be evident that the traveller, having ascended from London, on the outside of the pile,* to the top of the stratum No. 1, which is a portion of the North Downs, will suddenly begin to descend, passing over Nos. 1 and 2, at Morant's Court Hill, and crossing the valley of which No. 3 forms the bottom, will traverse the ridge of No. 4, from Riverhead, through Sevenoaks, to Riverhill; then again descending to the valley occupied by No. 5, (the vale of the Medway, in which is the town of Tunbridge,) he must again rise upon the Forest Ridge, and crossing the stratum, No. 6, obliquely, will at last descend rapidly, through the valley of denudation above mentioned, from Ore to Hastings.

(12.) The successive strata which the layers of cloth in our pile are supposed to represent, are as follows :—

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* London is situated in the lower part of a kind of trough or basin formed by a bending or wave of the chalk; and though lower with reference to the Sea than the chalk-downs, the bed called *London-Clay*, upon which the city is placed, with the sands and clays beneath, called *Plastic-Clay*, are both, geologically speaking, higher than the chalk.

	Feet.
1.—*Chalk.* A substance too well known to require a description. The thickness, when complete, is estimated at	700.[*]
2.—Marly Stone and Sand, with numerous green particles, frequently including concretions of chert, and in some places beds of stone, which, from its application in the construction of furnaces, ovens, &c. is called *Firestone.* This bed is known to Geologists under the name of *Upper Green-sand*	100.
3.—Blue Clay, very distinctly seen on the shore near Folkstone, a place celebrated for the beauty of the fossils which the stratum affords there. It bears the name of *Gault.* About	150.
4.—A thicker group of Sand than No. 2, including beds of stone called Kentish Rag, and of Fuller's Earth. The sand is at the upper part ferruginous, and in the lower abounds in green particles. This stratum is now called *Lower Green-sand*	250.
5.—A bed which has obtained the name of *Weald-Clay,* from its constituting the floor of the valleys called the Weald of Kent, Sussex, &c.	300.

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[*] The thickness of the strata in this list, is taken from M. Delabeche's "*Tabular and Proportional View of the Tertiary and Secondary Rocks.*" Second Edition, 1828. Treüttel and Würtz, London.

Feet.

6.—Another group of sand and clay, of various shades of grey and ferruginous yellow; including beds of hard calciferous grit, shale, ironstone, and bluish limestone. To this stratum, from its surrounding that place, the name of *Hastings-Sands*, has been given .... 400.

7.—Beneath the sands is a group, which is not seen upon the coast near Hastings, and is but obscurely, if at all, disclosed in the interior near Battle; where, from an upheaving such as has been described above, the continuity of the sands, No. 6, has been broken, and, (perhaps,) a portion of No. 7, brought into view. The beds thus rendered visible, have been supposed to be the upper members of a group, which has been named from the Isle of *Purbeck*, where it is fully seen. About .... 250.

8.—The stratum which affords the *Portland-stone*, so well known in the buildings of London, is immediately below the Purbeck group. The beds consist of continuous layers of stone, which, in the Isle of Portland, is oolitic, or of concretions included in sand. These beds are not any where visible within the tract under immediate consideration; but are mentioned here, for a reason which will presently appear .... 120.

(13.) The relative extent which these strata occupy, on the line of road from London to Hastings, and upon the coast, is shewn in two of the sections in the Plate, figures 1 and 2; and it will be seen, by a comparison of those sections, that the same beds are passed over in both, and that the proportions are not very different.

(14.) The several groups above-mentioned agree with each other in general position; and, like the rest of England, are composed of different varieties of sand, clay, and limestone; but they have been found to differ very remarkably in the character of the fossils which they contain. For, while the chalk and other beds at the upper part of the pile, down to the Lower Green-sand inclusive, and the Portland stone, at the bottom of the series, contain exclusively marine remains, the fossils of Nos. 5, 6, and 7, belong, in a great measure, to fresh water: and all the facts relating to these latter beds are such, as to make it highly probable that they were formed by deposition from the waters of the estuary of some very large river, upon a former surface of the globe.

(15.) It is to Mr. Mantell, of Lewes, that we are indebted for the principal evidence upon this very curious subject. It was, indeed, long ago suspected, that the shells of the Petworth or Sussex marble, which occurs in thin beds within the clay in many parts of Kent, Surrey, and Sussex, belonged to fresh-water species; and the late Mr. Sowerby had from thence inferred, that more of the deposits of fresh water were to be found among those usually considered as marine, than was at that time supposed.* But it was not until the appearance of Mr. Mantell's Illlustrations of the Geology of Sussex, in 1822,* that the full value of the evidence which this district affords was made to appear. In that excellent work, the author, besides illustrating very ably the fossils of the other strata in his neighbourhood, showed clearly that the extraordinary remains discovered, for the greater part by himself, in the beds of Tilgate Forest, must have originated in a lake or estuary, and have been the produce of a climate much warmer than that which is now enjoyed in England. But, for the purpose of reconciling his own correct observations with the views then entertained (as it now appears erroneously) by some other Geologists, Mr. Mantell was compelled to regard his Tilgate beds as a peculiar and distinct deposit, apart from the general stratification of the country. And, though he afterwards ascertained that stone of the same kind with that of Tilgate, is found in several other parts of Sussex, the characters of the "Iron-sand" (the name at that time given to the stratum which includes those beds) still appeared to be at variance with itself; for it was certain, that in some other parts of England, sands which then bore the same name contained *marine* fossils in great numbers and variety.

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* Mineral Conchology, Vol. 1. p. 76.—Genus Vivipara.

(16.) These anomalies were removed in a paper by Dr. Fitton, published in the Annals of Philosophy, for November, 1824[*]; in which it was proved that there are, in fact, *two* "Iron-sands;" one of them, No. 4, exclusively marine as to its fossils, and previously confounded either with No. 2, the stratum immediately below the chalk, or with No. 6; the other, No. 6 itself, separated from 4 by the Weald-clay, No. 5, and containing only, or for the greater part, the productions of fresh water:—the facts connected with the strata, from 5 to 7 inclusive, agreeing with the supposition that they were all deposited in fresh water communicating with the sea. It was necessary, therefore, in geological arrangement, to separate this group, both from the green-sand and chalk above, and from the Portland strata below them: and the Tilgate stone with all its remarkable fossils, thus fell into its proper place, and was proved to be one of the subordinate members of an extensive series of strata, of uniform character throughout.

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* *The Fossils of the South Downs, in illustration of the Geology of Sussex.* By Gideon Mantell, Esq. F.L.S.A., &c. 4to. London, 1822.

(17.) These views of the structure of the south-eastern coast have been confirmed by subsequent observations; and we shall now extract from the different papers which have been published upon this subject, and in some cases from unpublished notes, a short account of some of the principal points, which the geological visitor at Hastings will find to be deserving of his attention.

It is only fair to add, that we shall use the term

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[*] Ann. of Phil. New Series, vol. viii. p. 365, &c.

vicinity, with much greater latitude than it commonly receives. The essence of Geology consists, in fact, in *general* views, and one of the best practical accomplishments of the Geologist is mobility; for the features of the globe are on so vast a scale, and the facts to be brought together lie often so wide apart, that it is only by great activity in observing, and by very careful inference from what we see, that good results are to be hoped for. The best gift, therefore, that could be offered to the learner would, perhaps, be the power of transporting himself at will to distant places, and of floating above the surface of the earth, at such a distance as to seize upon the general features, and contemplate their relations at his ease,—descending, from time to time, for the purpose of studying the coast-sections in detail. In the mean time, he must be content to use the more humble conveyances of common life; and with their aid to make the best approach he can to this desirable ubiquity of mind and body. His progress in Geological knowledge and discovery will be proportioned to his success in the attempt, and he may obtain some measure of his zeal from his alacrity in attending to these recommendations.

BRIGHTON TO BEACHY HEAD AND SEA-HOUSES.

Chalk, No. 1, and Upper Green-sand, No. 2.

(18.) There are few places in which the chalk can be studied with greater advantage than along the range of cliffs which begin at Brighton and terminate a little to the east of the magnificent precipices of Beachy Head. The upper surface of the chalk begins to rise on the shore near the town of Brighton, from beneath a series of beds like those of the London basin; and these upper beds appear to have once covered the whole or the greater part of the chalk continuously; for large tracts are occupied by them around London, and in Hampshire, and detached portions occur, between these tracts, on the coast near Newhaven and Seaford, in Sussex, and at several places in the interior. The solid beds of chalk may be seen to rise very gradually, at the foot of the cliff near the Chain Pier at Brighton; but, from thence to Rottingdean, the greater part of the cliff is composed of an accumulation of transported matter, of which, however, a large proportion consists of fragments of chalk. It would seem that this part of the shore was the remainder of an excavation formed within the chalk, when at some former period that stratum occupied a much larger space towards the sea than it does at present; and the upper part of the chalk which still remains, appears to have been disturbed, or almost suspended in water, before its complete consolidation, so as to admit of a slight derangement of its parts, without being entirely broken down: for the veins of flint, by which the mass is traversed, are in some cases shattered, into pieces which are a very little detached from each other, but without derangement of the general course of the vein. A description of most of their appearances at this place, will be found in Mr. Mantell's Geology of Sussex.

(19.) The surface of the chalk downs in the interior, from Brighton to the escarpment which overlooks the Wealds, exhibits, beautifully, the effects of the denudation; and, on the shore near Cuckmere, a remarkable series of hillocks, called "the Seven Sisters," are evidently remaining portions of what was once a continuous range of chalk. It will be remarked that the valleys thus produced, are in general without streams. The chalk imbibes moisture so rapidly, or allows of such easy passage of water through its fissures, that rain is absorbed by the surface before it can accumulate into streamlets. But, in return, copious springs break out at the bottom, where the beds containing a large proportion of clay become retentive; and all along the foot of the chalk hills, these perennial springs unite to form rivulets upon the clay of the *Gault,* No. 3, beneath.

(20.) The chalk of this country, like that of other tracts in England, admits of subdivision into three obvious groups, founded upon very natural distinctions: —1st. The uppermost and whitest portion, abounding in nodules of dark grey flints, which commonly are distributed in regular ranges, a few feet apart.—2nd. In the second group descending, the flints are fewer, and at last they almost wholly disappear; the chalk is in many parts sandy.—3rd. Still descending, the rock, which now takes the name of *Chalk-marl*, acquires a softer consistency; its colour is yellowish or bluish grey. It melts away when exposed to water, and crumbles as it dries. The transition from this marl, through various shades of grey, to the upper green-sand, No. 3, beneath, is almost imperceptible; the green particles (silicate of iron) which abound in this latter stratum, and have given it the name, appearing, at first sparingly, at some distance within the marly beds: so that, in a strictly natural arrangement, the upper green-sand may be regarded as a part of the chalk itself.

(21.) In consequence of the very gradual rise of the strata on the coast of Sussex, the same beds continue to form the cliffs, for considerable horizontal spaces; so that the upper flinty division of the chalk is still found in the loftiest part of Beachy-head, where the projecting turret-like masses, called "The Charleses," which consist of chalk with flints, are not much less than five hundred and fifty feet above the sea. All the subdivisions, therefore, of the chalk, may be seen and studied, between the Gap at Cuckmere and Sea-houses. Among the most remarkable appearances are, the *continuous* veins of flint, in various positions, vertical, inclined, and horizontal, and from one inch, or less, to six or eight inches, in thickness,—which, in some cases, can be traced for several yards without interruption. The chalk itself, towards the middle and lower part, is here divided by rifts, which have a certain degree of regularity, rudely resembling the cleavage of crystals; the fissures are continued through large spaces; and being inclined to each other at the same angles, or nearly so, they divide the mass which they traverse into vast blocks, of somewhat regular figure, and of four and five sides.

(22.) As we approach the bottom of the chalk, the marly beds acquire a darker hue, and become more diffusible in water: when these softer materials come up within the range of the waves,—as they do in some places from bendings in the strata, before the general rise of the whole would have brought them to the surface,—the support of the more solid beds above is destroyed, and a very striking alteration is produced in the features of the shore. When the cliff is composed entirely of the upper and firmer chalk, the face is vertical, though the decay is constant, and perhaps more rapid, from the continual exposure of new surfaces. But when the marl rises to the base, the upper strata are soon undermined; and, tumbling in enormous ruins, form a rugged mass, which, if not immediately carried off by the sea, is soon covered with vegetation, and ultimately protects the cliff from rapid destruction.

(23.) The *Upper Green-sand*, No. 2, including beds of much greater firmness than the marly chalk, commonly runs out like a step beyond the foot of the chalk hills, and forms, in many places, a distinct and characteristic range of lower terraces. This is, in some measure, the case at Sea-houses, and along the base of the chalk-downs near Eastbourne; the low cliff at the former place being a wave or bending of the upper green-sand. But to see this stratum in complete developement, the Geologist must visit the Isle of Wight, or western Sussex; and, for the *Fire-stone*, one of the most remarkable products or subordinate members of it, the pits, or rather mines, of Godstone and Merstham, in Surrey, are the best places of study.

(24.) The *Gault*, No. 3, the stratum next below the Upper Green-sand, is very near the surface at Sea-houses, and may be seen at low tides, forming the basis of the cliffs. There are not however in this part of the country any good sections of this bed: but a beautiful section of it is exhibited at the corresponding place, upon the shore near Folkstone, on the opposite side of the great valley of the Wealds.

A very complete catalogue of the fossils of the chalk and subjacent beds in Sussex, has been published by Mr. Mantell, in the Transactions of the Geological Society,* since the appearance of his separate volumes; and figures of some of the most remarkable species are given in his previous works.

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* Geol. Trans. Second Series, Vol. III. p. 201.

LEWES.—*Mr. Mantell's Museum.*

(25.) The strata around Lewes are much concealed by the soil and cultivated ground, and by no means equal to the coast in affording facility of observation; they have, however, been fully explored, and are described in Mr. Mantell's publications. But the great geological attraction of the place is the admirable collection of fossils in the museum of Mr. Mantell himself. This very remarkable cabinet contains one of the most instructive collections any where existing of the chalk fossils, obtained from the cliffs and quarries of the adjoining country; and that from the Wealds, and the strata of the Forest-ridge, is unique. But it is not the beauty of the specimens alone that gives the chief value to this cabinet. The proprietor, amidst the discharge of his professional duties, has examined the country around him with indefatigable activity and perseverance, and has left nothing undone to throw light upon its fossil productions. His skill as an anatomist has enabled him to compare their structure with that of the analogous living species; and they have all been (so to speak) dissected, with so much dexterity and success, as to tell all that can be told, and in the plainest manner. An expedition, therefore, to Lewes, and an attentive examination of this collection, and of the publications connected with it, are indispensable to those who wish to derive from Hastings all the advantage which its position affords.

THE COAST NEAR FOLKSTONE.

Gault, No. 3, and Lower Green-sand, No. 4.

(26.) The general section, figure 2 of the plate, though on a very small scale, shews that the succession of the beds beneath the chalk upon the coast, corresponds to that on the road from London to Hastings, where it descends from the chalk downs, at Morant's Court Hill; and that, in both places, the *Upper Green-sand*, No. 2, is comparatively thin. In fact, between Godstone, in Surrey,—where this stratum is extensively quarried for the sake of the Firestone,—and the sea, the upper green-sand has not any where the prominence which it exhibits in Surrey, Sussex, and the Isle of Wight. Beneath Folkstone Hill, it is not more than eighteen or twenty feet in thickness; its fossils are few, and very indistinct; and it deserves attention chiefly as it proves that a representative of this stratum does exist upon the coast.

(27.) The *Gault*, No. 3, is seen, in great perfection, between the chalk cliffs and the village of Folkstone. It rises gradually from the sea, on the east of Eastware Bay, near to a place where the vertical face of the chalk is succeeded by an irregular under-cliff, produced by the fall and ruin of the superior beds, in consequence of the failure of support beneath,—just the same cause which has produced the well known under-cliff at the back of the Isle of Wight. A little to the east of this place, one of the copious springs already mentioned, breaks out from the top of the retentive beds of marly chalk, and is known by the name of "Lidden-spout." From hence, eastward, the chalk cliffs are continued, through Dover and the South-Foreland, to near Deal;—where the top of the stratum rises gradually from beneath loamy sands, belonging to the lower part of the *Plastic clay*. A minute account of these chalk cliffs has been published by the late Mr. W. Phillips, in the Geological Transactions.*

(28.) At the prominence called *Copt-Point*, (the nearest point of England, it is said, to France,) the cliff consists entirely of *Gault*, which here is about an hundred and twenty feet in thickness, and rests distinctly on the lower green-sand. The section of the stratum is well exposed all along the shore, to the village, where it disappears: and the beauty and variety of the fossils with which it abounds here, have given to the "Folkstone-marl" (as it has been sometimes called) considerable celebrity among collectors.

A full catalogue of the fossils of this place, with figures of the new species, will be found in a paper by Dr. Fitton in the Geological Transactions; and figures of many of those previously known, have been published in Mr. Sowerby's Mineral Conchology. A collection of great value, from the adjacent country, has been formed by Mr. Hills, of Lympne, and augmented by the researches of the Rev. G. E. Smith; and the writer of these pages can most fully attest the liberality and kindness of both these gentlemen, in affording the use of their acquisitions for the purpose of illustrating this country.

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* Vol. V. p. 16.

(29.) The *Lower Green-sand*, No. 4, rises from beneath the gravel of the beach, a little to the east of Copt-point; and it appears to have been the cause of the projection of the coast at this place; the firmness of the stony concretions within the sand "resisting, (to use the expression of an ancient Geologist,) the insults of the sea."* The section of this stratum here is remarkable for the distinctness with which it is subdivided into three layers or groups; which, on the shore, are strongly characterized, and may be traced from thence through Kent and a great part of Surrey, where they have had an important effect in modifying the features of the country.† A similar division of the stratum exists also in western Sussex, and, to all appearance, in the Isle of Wight; and, there is reason to suppose, in the interior of England also.

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* Woodward.

† Proceedings of the Geol. Soc., Dec. 1826, p. 8; and MSS. Notes.

1. The first and uppermost member of this subdivision, is from sixty to an hundred feet in thickness; it is seen rising gradually, beneath the sea between Copt-point and Folkstone; where it emerges, and caps the cliffs from the latter place to its disappearance on the top of the hills, a little to the west of Seabrook. This bed is chiefly composed of grey and yellowish sand, which, at the upper part, is remarkable for what is called the "false stratification" of its layers;—the mass of each bed, of two or three feet or more in thickness, being subdivided by seams of less regularity than those of the strata, oblique to the general direction, and frequently not more than an inch or two asunder. This part of the bed also contains numerous concretions of chert approaching to calcedony; in this and other respects resembling the sands of the Blackdown Hills, in Devonshire: and it includes numerous concretions of a conglomerate, which is formed of the sand cemented by calcareous matter, enclosing, along with the grains of quartz, a considerable proportion of greenish sandy matter, consisting of silicate of iron.

2. The second subdivision of the lower greensand is of nearly the same thickness as the first. It is of softer consistency, and, from a large admixture either of clay or oxide of iron, so retentive of water, that in many places there are ponds upon its surface, and springs break out

every where along the line of its contact with the sands above. The colour varies, according to the state of the iron in which it abounds; and it has in many places the character of a soft, dull, greenish, sand. This middle bed forms the lower and middle portion of the cliff between Folkstone and Sandgate; and, rising gradually in the heights which overhang the latter village, disappears, by thinning off, between Seabrook and the country on the north-west of Hythe. On the shore, it has been sometimes mistaken for clay; and, in the interior, it forms a flat, marshy tract, within the region of the lower green-sand, which has caused a similar mistake.

3. The lowest group of this stratum rises beneath the sea, close to Folkstone; it forms the ledges of rock which are visible at low water, along the shore under Sandgate; and, rising above the beach at Shorncliff, affords the stone which is quarried in the heights from thence to Hythe. It leaves the coast section finally at Aldington Corner. The sands of this subdivision abound in concretions of stone, somewhat like oblong potatoes, flattened; and frequently so close, as to be nearly continuous. It is in this bed also, that the quarries of Boughton, near Maidstone, are worked; and, all along the intermediate country, quarries are opened in it, for obtaining the siliciferous limestone, with disseminated dark green particles, well known under the name of "*Kentish rag*."

(30.) The fossils of the Lower Green-sand are very numerous, and, in the more sandy beds, they can be obtained in great perfection. An excellent collection of them has been formed by Mr. Hills, of Lympne, and the Rev. G. Smith: and a list, with plates of the new species, will be found in the paper already referred to, in the Geological Transactions.

THE WEALDEN.

Nos. 5, 6, and 7.

(31.) The fossils of all the strata hitherto described, are exclusively marine:—they are very abundant, and belong to numerous genera and species. Those of the group immediately below them, on the contrary, belong to a much smaller number of genera, and by much the greater part, to *fresh-water.* The beds include the remains of many reptiles of the lizard tribe; and all the existing species analagous to these, are amphibious, and known to inhabit the estuaries, or lakes, of hot countries. On whatever hypothesis this is to be explained, the facts are certain; and this zoological contrast in the fossil contents of the contiguous groups, is very remarkable. Yet, in the sections on the coast, there is no indication of disturbance; the beds of the lower green-sand reposing conformably upon those of the clay immediately below them: and, to all appearance, the change, from the deposition of the fresh-water remains to that of marine shells, may have been effected simply by a tranquil submersion of the land, to a greater depth beneath the surface of the waters.* Nor have any circumstances yet been noticed which give ground for conjecture as to the interval of time that may have passed between the accumulation of the strata, in the two cases.

(32.) The tract consisting of the Wealds of Kent and Sussex, and the forest-ridge between them, forms so important and striking a natural feature of the south-east of England, taking also into account the peculiar characters of its fossils, that some one term for their geological designation is desirable; and that of *Wealden*, suggested for the group, by Mr. Martin, of Pulborough, appears to be a very good one.

But though the fossils of this group, in all its parts, are of the same general character, even the species being the same,—and although beds of sand and clay are also found to alternate in every part of it, the tracts which the different portions of it occupy, are so much distinguished by natural features as to require its subdivision. The Weald-clay forms, both in Sussex and the Isle of Wight, the basis of a valley, surrounding a prominent ridge of the Hastings-sands. The Purbeck strata, on the other hand, consist, in a much greater proportion, of stone; and, in the Isle of Purbeck, (the only place where they are well disclosed,) they are detached from the ridge of the Hastings-sands, by a shallow but distinct depression.

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* In Western Sussex, however, cavities have been observed by Mr. Martin, in the upper part of the Weald-clay, occupied by sand, like that of the lower green-sand, and including some of the characteristic fossils of this latter formation.—MSS. Notes.

THE COAST NEAR HASTINGS.

Weald-clay, No. 5, and Hastings-sands, No. 6.

(33.) *Weald-clay.* In the interior of a country so highly cultivated as Kent and Sussex, it is very difficult to obtain a sight of a stratum of clay, especially in the lower districts; and it is only by availing ourselves of accidental openings, during the cutting of drains, or of roads, or in sinking wells, that the succession and contents of the beds can be ascertained. Mr. Mantell has lost no opportunity of examining the evidence thus obtained in Eastern Sussex; and Mr. Martin, of Pulborough, has published an excellent work on the west of that county, in which he has shown that this clay contains within it several beds of sand; so that it does not, in fact, differ from the subjacent group of Hastings and the Forest-ridge, except in the proportion of its parts. This Dr. Fitton has shown to be the case also in the Isle of Wight; and, to a smaller extent, on the Dorsetshire coast, where the best, or only, existing section of the whole of this group is disclosed.*

(34.) The occurrence of these firmer beds of sand, rock, within the softer strata of the Weald-clay, has produced a corresponding effect in the features of the country; the surface of the valley of the Wealds, not being smooth and uniform, like that of the Gault and of some other valleys of which clay is the basis, but marked by waving irregularities, which, in some parts of Kent and Surrey, can be distinctly referred to the prominence of these banks of stone; the hillocks thus projecting having a continuous range and uniform direction. Mr. Martin, in the work above referred to, has shown the course of these beds with great accuracy, in Western Sussex; and by similar attention, they could, no doubt, be ascertained and traced throughout the whole of the valleys of the Weald.

(35.) On the shore to the west of Hastings, the space occupied by the Weald-clay is a uniform flat, which, above the sea, is covered by the silt and mud of the marshes, near Pevensey, and is visible only, at low tides, beneath high water mark; but an attentive examination there would probably afford some good specimens of fossils. The well known "Sussex marble," as it is called, is found alternating with this clay, in the form of thin beds, which are nearly continuous, and could, it is probable, be traced throughout large tracts of the country. But the following are the chief places of its discovery hitherto mentioned by Mr. Mantell: Laughton near Lewes, Plumpton, Petworth, Kirdford, Newdigate, Charlwood, Storley-common, Tilvester-hill in Surrey, Bethersden in Kent.

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* Annals of Philosophy, Nov. 1824, and MSS. papers. —See the Plate, fig. 3 and 4.

(36.) Another component in this group is the argillaceous iron-stone, which occurs in very regular beds; and, it would appear, in more than one part of the series. This ore of iron was so valuable, when it was the practice to use wood-charcoal for smelting, that furnaces were formerly numerous along the verge of the Weald; the charcoal being obtained from the adjacent woods, and the ore principally from a group which will presently be mentioned.

(37.) On the East of Hastings, the Weald-clay makes its first appearance in the height on the west of Shorncliff, between Sandgate and Hythe; and then rising, occupies about half the space in the slope of the range of heights which rise from Romney Marsh, from thence to Aldington Corner. Some wells, at Hythe, have afforded the characteristic fossils of the stratum. A gritty limestone, resembling the marble of Petworth, &c., and like it also, containing numerous petrified shells, of the genus Paludina, with Cypris faba, is found in great perfection in the neighbourhood of Bethersden and Daniel's water.

(38.) The fossils of the whole of the Wealden can best be mentioned together, after the other strata of the group have been described; but the crustaceous genus Cypris, which occurs throughout the whole, is either so much more abundant, or so much more distinctly seen in the Weald-clay, as to be almost characteristic of it. Myriads of this little animalcule, resembling seeds, encrust the plates into which the firmer beds of the clay are divided. The general appearance of such a mass is represented (not very effectively) in the cut, figure 1, § 72; and the form of the external case is shown apart, in the magnified figures 2 and 3 of the same page.

(39.) *Hastings-sands*. The tract which is occupied by the strata designated by this name, has not yet been completely explored; and the examination of it is attended with some difficulty. The cliffs upon the coast, so far as they extend, are very instructive, but they do not go down to the bottom of the series; and in the interior, besides the difficulties common to all well-cultivated countries, the strata are every where so very much alike, and alternations are so frequent, the fossils also of the whole being nearly the same throughout, that it is scarcely possible to be sure that beds of the same appearance in distant points are continuous. Those, however, who are resident in the country, will, no doubt, be enabled, by attentive examination, to find distinctive characters in the tracts immediately around them, by which they may be assisted in tracing the strata into other localities.

(40.) In the mean time, the principal relations of the Weald-clay and the Hastings-sands may be learned with advantage from the sections on the south of the Isle of Wight, especially that upon the shore between Black-gang-chine and Compton-Bay, of which a general sketch is given in fig. 3 of the annexed plate; but on so minute a scale, it has been impossible to insert the detail of the stratification. The Hastings-sands consist throughout of beds of sand, calciferous grit, clay, and shale—with argillaceous iron ore, and limestone abounding in shells: and of these, *clay* intermixed with sand forms so very large a proportion, that the name of the stratum might, perhaps, have been, with equal propriety, taken from the former substance.* These sandy clays have, in general, great variety of composition and colour; being in some places almost totally composed of sand,—in others of clay, or Fuller's-earth, frequently mottled with various shades of tea-green, and dark purplish red. In these respects, the stratum in Sussex agrees with that of the Isle of Wight: the sands also including, at different depths in the series, concretional masses or beds of stone.

In the Isles of Wight and Purbeck, "the prin-
"cipal variation in the features of the coast is
"produced by the successive rise of the beds of
"sand-rock with calcareous grit; which, as the
"clays between are much less durable, form ledges

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* Annals of Phil. N. S. vol. VIII. p. 377.

"extending considerably into the sea. It is "to the superior solidity of these beds, the bony "skeleton, as it were, of the formation,* that its "resistance to the denuding forces which have "swept away such large portions of the adjacent "clay, must be ascribed, in the Wealds of Kent "and Sussex, and, on a small scale, in the Isle "of Wight."† These rocky ledges are well known to the seamen on the south-east coast; and it is not impossible that similar ledges may exist under the sea, upon the shore of Sussex. The Admiralty chart of the coast from Winchelsea to Beachy-head, does, in fact, represent several masses of rock between Bopeep and Cliff-end.

(41.) The composition of the Hastings-sands, in Sussex, in other respects, agrees with that of the Isles of Wight and Purbeck; but neither the order nor the thickness of the several strata has yet been completely ascertained. The following abstract of what has hitherto been published in relation to it, is given only as an approximation:—

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* By this term, Geologists denote a series or group of strata, which, though perhaps differing in composition, have such a character of uniformity, in structure, and in their fossile contents, as to indicate that they have been deposited, or "*formed*," about the same period, and under similar circumstances. The term is borrowed from the German, and is objectionable, as it implies some hypothesis; but it has been generally received.

† Annals of Phil. N. S. vol. VIII. p. 377, 378.

Supposed Order of the beds of the *Hastings-sands*, in Sussex, &c.

A.—*Ferruginous and fawn-coloured sands, and sand-rock*, including small linear portions of lignite, with stiff grey loam.

Localities. Chailey; L. Horsted, Fletching, (tops of the hills), Eridge Park; Uckfield, Framfield; Bexhill, and adjacent shore; the highest part of Fairlight-down; Tunbridge Wells, tops of the hills. On the north-east of the Forest-ridge, in Kent, the strata have not been explored.

B.—*Sand-rock.*

Inclined beds, West of White-rock; and top of Fairlight-down. (Webster.)

C. *a.*—*Sand-rock*, including *b.* (Webster,)

b.—Concretional courses of *calciferous grit*, included in *a.*

Horsham; stone of Tilgate-forest, St. Leonard's-forest; Loxwood; Ore near Battle; White-rock, East-cliff, Hastings; near Eaglesbourne; Winchelsea; Rye. The grit of Hollington, near Hastings, is of this kind, but has not yet afforded any of the great bones.

D.—Dark-coloured *shale*, ten to twelve feet thick. (Webster.) Mantell also mentions such a group. (Tilgate, p. 32, note.)

White-rock, Hastings; West-cliff, under the castle; East-cliff; Eaglesbourne;

E.—The *white sand-rock* of the Hastings-cliffs; about 100 feet thick.

Tunbridge Wells; Worth, near Crawley; Hastings, West-cliff, over and behind Pelham-place; Eaglesbourne, &c.

F.—*Clay*, *shale*, thin beds of *sandstone*; lignite and silicified wood (*Endogenites erosa*).

Tilgate; Newick; Waldron; West Cliff, Hastings, behind Pelham Place; East Cliff, about one third up; not traceable further to the east. (Webster.)

G.—*Sand-rock*, without concretions; dividing naturally into rhomboidal masses; numerous veins of argillaceous iron-ore, and of clay, approaching to pipe-clay at the lower part. (Webster.)

[Variegated sands and clay, of a tea-green colour, mottled with patches of dull crimson or purplish, form a large portion of this formation in the Isle of Wight.]

East Cliff, Hastings; level of the beach at the west end; towards the East, Lovers'-Seat, and Fairlight-Cliff; clay with red stains or patches.

H.—Dark-coloured *shale*, with roundish masses of *sand-rock*, and several layers of rich *ironstone*, thin layers of lignite, and innumerable fragments of carbonized vegetables.

West of Eaglesbourne, to about 12 feet above the beach; Cliff-end at low water, forming a ledge. (Webster.) The Ashburnham group of Mantell;—occurring at Ashburnham itself; Chorley; Eason's Green; Pounceford; Burwash; Hurst Green; Etchingham; Brightling; Archer's (or Orchard's) Wood, near Battle; Crawley, on the N.W. of the Forest-ridge.

This general view, though it requires much correction, will assist the reader in arranging the following observations on some detached points deserving of notice in the country. And it will be convenient to consider the strata under the heads of,—Sand and Sand-rock, with Calciferous

Grit;—Variegated Clay and Loam;—Slaty Clay and Shale, with Iron-ore.

Sand, and Sand-rock, with Calciferous Grit.
(A, B, C, *a* and *b*, and E, of the preceding list.)

(42.) *Bexhill, Horsted, &c.* (A.) The Weald clay being, in fact, continuous with the sands beneath, and the division in a great measure artificial, no very exact boundary can be traced between them. The rise towards the forest-ridge is gradual, and the lowest beds of the clay alternate with beds of sand. The group which Mr. Mantell calls the *Horsted-sand*[*], and which rises on the shore near Bexhill, may be placed upon these doubtful confines of the two formations; the beds being distinguished by 'a very large intermixture of small 'linear portions of lignite,' with the sand-rock, which alternates with a stiff grey loam or marl.

(43.) *Sand-rock of Hastings.* (C, *a*;—and E.) The cliffs near Hastings, from the White-rock to Cliff End, have been described by Mr. Webster, in a paper[†], which is illustrated by two plates, representing the general section of the coast, and the detail of some curious appearances at the White-rock. Mr. Mantell also has described these cliffs, in his volume on the Fossils of Tilgate; and from these works the preceding list of the stratification has been derived. The most characteristic portion of the cliffs near the town, is the thick and conspicuous bed of friable whitish sand-rock, which Mr. Mantell considers as the same with that of Worth, near Crawley, and of which examples may be seen in some places on the London road to Hastings. The rock, if it can be called so, is composed of siliceous grains, so little cohesive that the large blocks thrown down from the top, become mere sand on striking the bottom. Extensive caves have been worked into this bed, for the purpose of procuring sand at different points of the cliff. The same bed forms the middle of East Cliff; but there, large kidney-shaped concretions of the stone above mentioned occur in it, increasing in number towards the East, near Eaglesbourne; beyond that place the bed extends to the Covehurst and the Lovers' Seat, which Mr. Webster supposes to be its eastern boundary upon the shore.

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[*] Fossils of Tilgate, pp. 28, 29.

[†] Geol. Transactions, 2nd Series, II. p. 31, &c.

(44.) *Calciferous Grit.* (c, *b.*) *White-rock,* Hastings. The characters of the calciferous stone, which forms one of the principal features of the Hastings cliffs, and appears to be distributed throughout the sands,—were some years since very well displayed, at the White-rock, whence Mr. Webster's drawings have been taken; but the recent destruction of the fallen masses at that place by the sea, has unfortunately defaced some of the most interesting appearances. The blocks of grit have the usual mammillated or kidney-shaped figure of concretions; and Mr. Webster has well distinguished the depressions on their surfaces, arising from this structure, from the cavities worn by the friction of pebbles in the blocks which have been long exposed to the sea *. The stone consists of sand, agglutinated by carbonate of lime, and in many cases has the lustre and fracture of calcareous spar. But when the blocks have been acted upon by long exposure in their original place within the sand,—as in the face of the cliff on which the town of Rye is built,—the effect of decomposition renders the original structure more apparent, and the courses in the stony masses, are seen to be continuous with those of the sand immediately adjoining them. It is not, indeed, impossible, that a new arrangement of the carbonate of lime, derived from the shells within the sand, may have given origin to these nodules; for in some parts of the sand-rock, vacant moulds of the shells alone are found; whilst, in the blocks of calciferous stone, the place of the shell is occupied by carbonate of lime:—as if the calcareous matter had been transferred from one portion of the sand in which the shells were originally diffused, so as by its abundance to agglutinate the particles in other places.

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* The appearance of the cavities thus worn in some of the blocks near White Rock, in which the foliated structure also has become apparent, illustrates beautifully the formation of valleys of denudation, represented in the wood-cut at p. 5. Each of the worn cavities, in fact, is such a valley; and the intersections of the strata by the new denuded surfaces, are precisely like what occurs on a larger scale in stratified countries.

(45.) *White-rock.* Mr. Mantell gives the following list of the beds at this place, which he supposes to belong to the same group with those of Tilgate Forest.

1.	Loam and vegetable mould.	
2.	Sand and friable sandstone	3 to 5 feet.
3.	Tilgate-stone; with casts of bivalves .	2 —
4.	White and fawn-coloured sand . .	15 —
5.	Tilgate-stone with bivalves	1½ foot.
6.	Thin layers of a coarse friable aggregate; with remains of fishes, vegetables, and shells (Paludinæ) . .	2 to 6 inches.
	[The specimens of *Endogenites erosa*, frequently thrown on shore by the waves, are from this bed?]	
7.	Ferruginous sandstone; with layers of blue clay and shale; and numerous traces of carbonized vegetables . .	3 to 4 feet.

(46.) *Hollington*, near Hastings *. A bed or group of beds of this calciferous grit is exposed in the course of the streamlet which crosses the road from Hastings to Hollington, and was some time since quarried for the repair of the roads. The rock is naturally divisible into flags, from two to six inches thick, the surfaces of which are waved with ridges, somewhat like those upon the shore after the retreat of the tide. The stone is of a light blueish grey colour, with a fine splintery fracture; more resembling sandstone than limestone, but yielding to the knife, and effervescing with acids. It contains a few specks of iron pyrites, and includes, in great numbers, the remains of one or more small bivalves, *Cyrena media* principally, and of a spiral univalve, *Paludina elongata*;—with, more rarely, *Cypris Faba*. In some portions of the firmer grit, the space once occupied by the shell is filled with carbonate of lime; in others, the stone is of a soft and spongy texture; consisting apparently of fine concreted sand, and including vacant moulds of the shells, of great delicacy. The beds here are nearly horizontal, or perhaps inclined a little, to a point about 20° south of west.

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* MS. notes.

(47.) *St. Leonard's* *. Beds of grit and conglomerate, abounding in the remains of fishes, were quarried during the progress of the works at St. Leonard's, in the face of the precipitous hill on the west of that place, towards Bulverhithe. The stone is in some parts distinctly composed (like some of the beds of Tilgate,) of siliceous grains, cemented by calcareous spar,—and includes the *Paludina elongata* and *P. carinifera*, with myriads of small bufonites, and scales and fragments of the bones of the fish (*Lepisosteus*) which is so common throughout the Wealden. Beneath these beds of stone were thin layers of a greenish grey sand-rock, containing a new species of Cyclas, *C. concentrica*:—the whole mass of the strata sloping a very little towards the east. In the cliff at Bulverhithe, part of the femur and tibia of the Iguanodon have been found, and are now in the possession of Dr. Chapman †; and specimens of the

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* MS. notes.

† Mantell, MSS.

Endogenites erosa occur, though rarely, in the conglomerate of the same place.

(48.) During the summer of 1830, in the face of the hill to the west of the Assembly Rooms, a *fault*[*] was partially brought into view, in cutting away the bank or hill to make space for some new buildings; but its extent was not fully disclosed. The surface then visible was nearly at right angles to the shore, and was cut vertically by a distinct line or fissure; the south or sea side of which was occupied entirely by grey clay; whilst on the north or inland side the upper part consisted of beds of sand-rock, dipping slightly to a point about 20° east of north, abruptly cut off by the fault, and abutting against the grey clay. These sand-rock beds reposed on a mass of greenish grey clay, like fuller's earth, which also was cut through by the fault;—this effect being, most probably, one of the numerous re-

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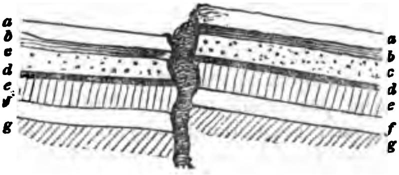
[*] *Fault* is a technical term used to express a sudden discontinuance and displacement of strata; the separated portions being frequently found at different levels and differently inclined. Thus—



The interruption is sometimes a mere crack; in other cases a wide fissure, generally occupied by looser matter than that of the strata themselves.

sults of the violence to which the whole of this tract has been subjected.

(49.) Of the eastern side of the forest-ridge, the places of the occurrence of this thin Tilgate stone have not yet been ascertained; except in the vicinity of Tonbridge Wells*. In the Ordnance map, however, of the south-east of Kent, quarries are represented in such great numbers, in a tract about midway between Goudhurst and Smarden, from Frittenden to Biddenden,—a part of the country which corresponds to the rise of the Hastings sands,—that the equivalents of the Tilgate strata may very probably be found there.

(50.) *The Beds of Tilgate Forest*, (c, *a*, and *b*,) now well known from the multitude of new and extraordinary fossils which Mr. Mantell has discovered in them, belong to the upper part of the Hastings sands. They are described, in the work already referred to †, as consisting—

1st, Of sand and sandstone, (c, *a*,) greenish, yellowish, and ferruginous; the surface of the stone being often furrowed by waved ridges, like the ripple-marks left upon a sandy shore by the retiring tide.

2nd, Of the *Tilgate Grit* (c, *b*,);—a compact calciferous stone, inclosed in the lower strata of the sand and stone just mentioned, and consisting of large kidney-shaped masses 'of compact cal-'ciferous grit, of a light grey colour, inclining to

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* See Mantell's Notice in Mr. Britton's 'Topographical Sketches,' &c. p. 10—11.

† Fossils of Tilgate, p. 29.

'blue or green, and composed of siliceous sand, 'cemented by about 25 per cent. of carbonate of 'lime.' Some portions of these beds are a conglomerate, containing pebbles of quartz and jasper, many of which have evidently been water-worn;—of this kind are three or four layers, varying in thickness from 1 or 2 inches to 18.

(51.) In the Isle of Wight a thick bed of sand-rock, including large concretional masses of grit, lies above the general mass of the Hastings sands; from which it is separated by a group of sandy clay, in thin beds, alternating with shale*. This corresponds nearly to the place of the Tilgate stone;—and the occurrence of the Tilgate fossils in the Isle of Wight is nearly certain; bones of an enormous lizard (perhaps the Iguanodon) having been found in great numbers at Brook Point (see the Plate, fig. 3), which is the site of one of the remarkable rocky ledges above mentioned. Similar remains have been obtained also from the Hastings sands in Swanage Bay (see the Plate, fig. 4); so that scarcely anything is wanting to prove the identity of the formation in these three distant points†.

Variegated-Clay; and Sand‡.
(G, of the preceding list.)

(52.) *Lee-Ness Point.* The highest point or turn of the curve which the strata form upon the

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[*] Geol. Soc. Proceedings; and MS. notes.

[†] Geol. Soc. Proceedings, p. 159.

[‡] From MS. notes.

coast near Hastings, is on the east of Lee-Ness Point; between a wooded depression called Haddocks'-rough, and another wooded ravine on the west of the Lovers'-seat,—a place which corresponds nearly to the axis of the ridge, that passes from the shore through the highest point of Fairlight Down to Battle. Lee-Ness Point, itself, consists of a great bed or floor of sand-rock; which,—being traversed by long continuous and nearly parallel fissures, in a direction from the north of west to the south of east, and crossed obliquely by other cracks,—has a rude resemblance to a sort of pavement. The top of this bed, at the point, contains disseminated granular portions of a red oxide of iron, like that hereafter mentioned; and beneath the sand-rock, is greenish and purplish variegated clay. From this point the strata of the coast decline very gradually on both sides; so that the sand-rock, with concretions of calciferous grit, which occurs in the highest portion of the cliffs at Hastings,—having gradually risen from the shore between Bexhill and the White-rock,—declines again, and is visible at Rye; where the calciferous masses are found *in situ*, in the face of the prominent mass of rocks upon which that town is placed: and they are also seen in the continuation of the same stratum in the cliffs at Pleyden, on the N.W. of the river.

(53.) *The Haddocks.* In the vertical face of the cliff, immediately on the west of the Haddocks,—and of the site of a Watch-house, taken down a few years ago,—a group of beds occurs about midway up, among the strata of variegated clay, which is deserving of notice and of further examination. The cliff here, in general, corresponds to the portion G of the preceding list, from Mr. Webster's section; and is in great part composed of greenish grey sand, stained, as it were, with patches of a dark reddish and purple hue; and among the fallen masses on the beach are portions of Fuller's earth, which melts away in water,—in thin beds, alternating with lighter coloured fine sand. On the shore here are also large masses of a greenish white sand-rock, including numerous somewhat globular nodules of pyrites, and containing also lignite, and impressions of the stems and leaves of vegetables in great numbers. About midway up the cliff is a portion composed as follows:

	Ft.	*In.*
Marly ? stone, full of granular particles of reddish brown oxide of iron	0	9 or 10
(Above this is another similar bed.)		
Soft sand-rock, obscured by debris . about	6	0
Greenish-white firmer sand-rock, having almost the consistency of grit . . about	0	9
Sandy beds,—whitish, inclining to greenish grey	7—8	0
Another purplish band, with green patches.		

On the shore, about 250 paces to the west of this place, is another group of beds, about 15 feet thick, of greenish and reddish marl, variegated in patches, with a range or band of granular oxide of iron about the middle;—and among the debris are many large portions of trunks of trees, converted into lignite, like those of Brook Point in the Isle of Wight.

(54.) *Granular, or Pisolitic, Iron-ore.* The oxide of iron disseminated in the sand-rock, in the manner above described, consists of grains, of various sizes, but generally less than $\frac{1}{10}$ of an inch in diameter, with a dull earthy aspect, an even fracture, and of a dark reddish or Spanish brown hue; the texture is most commonly uniform throughout, and the grains quite solid; but in some few cases a small nucleus or cavity is within, surrounded with a shell or coating of the reddish matter. From the occurrence in other parts of the cliff of globular masses of pyrites, though much larger than these reddish grains, it is not impossible that the grains may be no more than one of the forms of decomposed pyrites;—that being the origin assigned to this variety of the pisolitic iron-ore by Mohs*. Their existence in such abundance in this part of the Hastings sands, supplies an additional point of resemblance to some of the formations above the chalk, hitherto considered as the chief site of this ore of iron:—and it may assist in recognising this member of the Wealden group in doubtful cases.

Slaty-clay and Shale, with Iron-ore.

(D, F, and H, of the preceding list.)

(55.) *Trials for Coal.* The slaty-clay and shale which occur in different parts of the Wealden, alternating with nodular ranges of clay iron-ore, and with beds of a somewhat argillaceous compact limestone,—are interstratified with sand-rock, and frequently inclose portions of carbonized wood and of lignite. This assemblage, therefore, is very nearly the same in mineral composition with that of the coal measures, in a much lower part of the series of strata; differing from it only in geological place and in the character of its fossils. It is not surprising, therefore, that, at a time when the geological relations of the groups in England were less understood than at present, these carboniferous portions of the Wealden group should have excited hopes of discovering coal within them in sufficient quantity for working;—and the borings, which some years ago were conducted with that view at Bexhill, were much more excusable than has been supposed *.

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* Mohs' Mineralogy, translated by Haidinger, vol. ii. p. 412.

(56.) 'The lowest strata visible in the section
' on the coast, consist,' according to Mr. Webster,
' of dark-coloured shale, which is seen at the
' Govers, and Cliff End, and contains roundish
' masses of sandstone; together with several layers
' (two of them of 2 to 3 inches thick) of rich ar-
' gillaceous iron-ore. With these are found abun-
' dant thin layers of lignite, and innumerable frag-
' ments of carbonized vegetables, among which
' ferns are recognisable. It is from these beds
' that the rich iron-ores of Sussex, which were
' formerly much worked, have in some instances
' been procured. On the west of Eaglesbourne

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* A list of the strata passed through in these attempts, is given in Mantell's Sussex, &c. p. 35.

'this last bed rises in an arch to the height of 'about 12 feet, and then descends to the east. 'At Cliff End it reappears, and may be traced at 'low water, forming a ledge.'

(57.) *Ashburnham Beds* [*]. In the tract around Ashburnham and Penhurst, a group of several feet in thickness rises uniformly from the west towards the heights of Brightling Down. The component beds are—compact slaty clay, including the Cypris (*Faba*), in great abundance; thin slaty limestone, with numerous Cyclades; and thin nodular bands of a poor argillaceous iron-ore, used at present only for the manufacture of Tripoli,—and to the various beds of which the odd names of "Pity," "Clouts," "Caballa-balls," &c. have been given by the workmen [†]. These substances recur in frequent alternations; then finally, below all, is sand-rock.

This group breaks out in the N.W. face of the low range of hills which forms the ridge on the N.E. of Herstmonceux, which seems to be the first rise of the Hastings-sands from the flats of the Weald, and on which are the little villages of Boreham Street and Gardner's Street,—a situation, it will be seen from the map, which would place the strata rather near the top than at the bottom of the Hastings-sands. A good section is visible in the road, which rises on the S.E. of Ashburnham, from Henley bridge, to that which leads from Wilson's farm to Browning's; and the strata are on the surface in several places along the continuation of that road, through Maresfield Cross, Pont's Green, Latterden, and Herrings. The beds of iron-ore, in all, or most of these places, are recognised by the workmen under their appropriate names *. The shale comes close up to the foot of the ridge, upon which Wood's Corner is placed, and which, immediately beneath the inn, is composed of sand-rock beds, which dip to the S.E. Throughout the tract on the east of this line, towards Penhurst and Ashburnham, the presence of the iron-ore has been ascertained by sinking trial-shafts, so as to prove its continuity at depths from the surface corresponding to the variations of level. The group appears to exist on both sides of the Forest ridge; and from it the ore was obtained, of which, when wood was cheap, and charcoal was employed for smelting, iron was made, in numerous furnaces, the existence of which is still attested by the occurrence of slag, and other refuse, in many parts of the country.

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[*] From MS. notes.

[†] A detailed list of the beds here, is given, from the Agricultural Survey of Sussex (4to, 1793, p. 13—16), in Conybeare and Phillips's Outlines, pp. 139 & 148.

(58.) Mr. Mantell identifies the shales of Crawley and Eason's Green, Etchingham, Hurst Green, West Down, and Willingford, with the group of Ashburnham and Penhurst; and also the shales and limestones of Darvel's Wood near Battle, Pounce-

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* The guide from whose information these statements are given, was an experienced workman at Penhurst, named Stonestree.

ford*, Burwash, Brightling (Rounden Wood &c.), Archer's (Orchard's?) Wood, Barnet's Wood on the road from Lewes to the Black-Boy, Rotherfield; regarding this group as one of the lowest portions of the Hastings-sands. If this be the case, the conjecture that the Purbeck strata have been brought into view, by an upheaving and rupture, in some of the lowest points on the N.W. of Battle, is unfounded;—and the calcareous strata, accompanied and alternating with shale, which are mined or quarried in the places above mentioned, must all be considered as no more than dislocated fragments of the Ashburnham group, thrown up or down, and inclined at various angles, by the faults with which it is known that this part of the country is traversed.—In the present state of our knowledge, this may perhaps be the more probable case of the two: but it ought to be noticed, that some of the persons best acquainted with the country, and especially with the pits, &c. from which the limestone is extracted, distinguish between the iron-ore beds of Penhurst and Ashburnham, and the *limestone* beds of Rounden

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* The section at Pounceford is as follows:—

	Ft.	*In.*
Loam	8	0
Shale, including blue limestone 2½ inches	2	5
Soapy Marl	3	9
Sandstone	5	6
Calciferous Stone	1	10
Total	21	6

Then Blue Clay;—depth unknown. (Mantell: Tilgate, p.46.)

Wood, &c.: considering the former as separated from the limestone, not by a mere down-throw, or fault, but by an intervening mass of strata more than 200 feet thick.

(59.) *Lowest Strata of Sussex**. On consulting the Ordnance map of the country near Hastings, it will be seen that a lofty and prominent ridge extends without interruption from the shore, on the S.E. of Fairlight Church, to Battle; —Fairlight Down, about 600 feet in height, being its highest point. In the coast section it is seen that the top of the curve corresponds to the situation of this ridge; the strata declining from it on both sides to the S.W. and N.E. The ridge is lower on the N.W. of Battle, or rather seems to branch off to the west from that place; but a continuous ridge extends from Netherfield-toll to Dallington, and ground of sufficient height to cause a parting of the streams, connects that place with Mutton Hall. Again, a continuous ridge may be traced from the west of Etchingham, through Burwash, to Mutton Hall, and thence by Cross-in-hand to the Black-Boy and Framfield: so that the two ridges,—from Mutton Hall to Etchingham, and from the same point to Battle,—diverge at an angle of about 30°. It will be remarked, on examining the geological map of this part of England, that this angular junction of the ridges corresponds to the disposition of the beds at the western extremity of the Wealds;—where a similar opening and divergence in the chalk unveils the gault beneath it: and successive openings of the lower green-sand, and the Weald-clay, upon a line nearly continuous with that of the chalk, occur at the first rise of the Weald-clay and the Hastings-sands respectively. The space above mentioned, from Mutton Hall towards Brightling and Mountfie d, which nearly coincides in direction with the line above mentioned, is therefore precisely that in which the beds below those of Hastings might be expected to occur, if the displacement of the superior strata had been of sufficient extent to unveil them.

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* MS. notes.

(60.) It is within this irregular and lower tract, between the two ridges, in the depth of which considerable branches of the Rother take their rise, that much of the limestone, for which pits have been dug in several places in this part of the country, has been obtained; and the group which includes this limestone has been considered as the equivalent of the Purbeck formation*,—or rather of that group of shale, alternating with limestone in thin beds, which intervenes between the Hastings-sands and quarry-stone of Purbeck, and occupies the lower ground between the village of Swanage and the sand-cliffs on the north of it:—(See the section fig. 4. in the Plate.) From the general structure of the tract surrounding Brightling, the ravines at the base of the prominence on which the Observatory stands, ought evidently to afford the deepest strata of the country: but the whole of this tract, as well as all the central portion of the Forest-ridge,—(if not of the entire space between the North and South Downs,)—has been the scene of great dislocation *, and is traversed by many considerable fissures, or "faults;" which not only break the continuity of the beds, but most commonly are attended with changes in the level and inclination of the dislocated portions. Several "horses," as the quarrymen call them, or angular bendings in the strata, occur hereabouts; and one great fault is well known, which throws down the limestone more than 60 fathoms. Under such circumstances, the disposition of the strata becomes very perplexing; and as there are here no coal-beds to reward the labour and expense of accurate levelling and surveying, it is impossible at present to give a correct section of the country. The relations, therefore, of the Ashburnham group, and of the lowest strata in this part of Sussex, are still obscure, and are well deserving of more accurate inquiry.

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* Conybeare and Phillips,—" Outlines," &c. p. 148.

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* The effect of such ruptures, and the proofs of their occurrence in the tract before us, have been very well detailed, and connected with some interesting speculations, in a paper by Mr. Martin, 'On the anticlinal Lines of the Hampshire 'Basin.'—Phil. Mag. and Annals, (Feb. 1829,) vol. v. p. 111.

A good example of a saddle, on a small scale, is visible in the road near Burwash-wheel; and of a fault, in a deep valley near Swife's farm, not far from Pounceford.

PURBECK STRATA*.

(61.) As the occurrence of this group in the vicinity of Hastings is so doubtful, it will be sufficient to mention here, that the strata of the Isle of Purbeck consist principally of compact, splintery limestone, abounding in shells, and in some cases almost entirely composed of their remains; while other beds nearly resemble the stone used in lithography. The shells, and the other fossils of the group, are supposed to have been the produce of fresh water; but a remarkable exception occurs near the middle of the formation, where a bed of about twelve feet in thickness is almost exclusively composed of the remains of oyster-shells. The junction of this group with the marine strata of the Portland-stone beneath, is attended with some very remarkable appearances, to which it will be necessary to recur.

(62.) *Limited extent of the Wealden.*—Among the circumstances most deserving of notice, respecting the remarkable group of which the Purbeck limestone constitutes the lowest member, are, the comparatively small space which it has been, hitherto, ascertained to occupy,—and its gradual thinning off, as we approach its limits on the coast of Dorsetshire and in the interior of England.

The greatest superficial extent of the Wealden is disclosed in the Wealds and Forest-ridge of Kent and Sussex, &c. The two upper beds are fully displayed on the south coast of the Isle of Wight. In proceeding westward, the group crosses the Isle of Purbeck; but there, the upper strata are already much reduced in thickness; and from Worbarrow-bay it thins off very rapidly,—disappearing somewhere about Durdle-cove, on the Dorsetshire coast:—(see the sections, fig. 3. and 4. of the Plate): and from the observations of Mr. J. Phillips, it appears that no trace of the group is found on the opposite coast of France, between the chalk and Kimmeridge-clay, near Havre *. The existence of the Purbeck beds in the Vale of Wardour has long been known; and in that place the author has detected also some traces of sands corresponding to those of Hastings. Slaty limestone, like that which occurs in the upper part of the Isle of Portland, is found above the equivalent of the Portland stone at Brill and Whitchurch, west of Aylesbury in Buckinghamshire, and on the coast of the Boulonnois in France †. But besides these places, Beauvais, in the interior of France, is the only other locality in which any members of the Wealden have yet been shown, on good evidence, to exist ‡. The position of these extreme points gives, for the diameters of the formation, from west to east,—(Lulworth-cove to the boundary of the Lower

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* From MS. notes.

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* Phil. Mag. and Annals, (Mar. 1830,) vol. vii. p. 198.

† MS. notes; and Proceedings of Geol. Soc., 1826-7, p. 26;—Phil. Mag. and Annals, vol. ii. p. 220.

‡ Bulletin de la Société Geologique de France.

Boulonnois,)—about 200 English miles; and from N.W. to S.E.,—(Whitchurch to Beauvais,)—about 220 miles:—the depth or total thickness of the group, where greatest, being about 2000 feet.—A wide diffusion of the strata, certainly, if they were the product of an estuary; but by no means greater than that of many of the actual deposits in the estuaries of some of the larger rivers on the present surface of the globe. The Delta of the Ganges, for example, is not less than 160 miles from east to west along the coast, and from north to south, (from Burhampour to the Bay of Bengal,) about 170 miles;—that of the Mississippi occupies a tract more than 170 miles from E. to W., and more than an equal extent from N.W. to S.E.[*];—whilst that of the newly-discovered Quorra, or Niger, in Africa, stretches into the interior for more than 170 miles, and occupies, it is supposed, a space of more than 300 miles along the coast,—thus forming a surface of more than 25,000 square miles, or equal to about one half of England[†]. These facts, therefore, concur with others in favour of the hypothesis, that the Wealden strata were deposited beneath the waters of an estuary. But upon this, as on every other subject of physical investigation, we should be careful to regard the most plausible mode of explaining the phænomena, as only provisional;—to be modified hereafter, or even totally rejected, if future discoveries be opposed to it.

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[*] These numbers, taken from Pinkerton's Atlas, are only an approximation, but sufficiently near to the truth for the argument in the text.

[†] Lander's Travels,—referred to in the Edinb. Review, No. 110, vol. lv. p. 415.

FOSSILS OF THE WEALDEN.

(63.) The fossils of the whole group to which the name of Wealden has been given, have so much affinity, that they may properly be considered together; and they seem to be distributed with much uniformity throughout the strata. A great number of the remains of plants, and of reptiles, have been represented in Mr. Mantell's publications, from which very principally the following abstract is taken; the greater part having been discovered by himself in the calciferous grit of Tilgate-forest: but they are by no means confined to that place, and have been found there in greater abundance, simply because the stone of Tilgate has been very extensively opened in quarries for the repair of the roads. The remains of the great Saurian reptiles certainly occur throughout the whole series of the Wealden strata, from the upper part of the Weald-clay, down, at least, to the lowest beds of the Hastings-sands.

Plants.

(64.) The vegetable fossils of the Wealden appear to be the remains of plants analogous to those which are at present known to be peculiar to tropical regions;—and nearly allied to the palms and tree-ferns. Their existing types are only to be seen in hot-houses, in this country*; and a mere enumeration of the names which they have received, without the aid of plates, would afford but little instruction to our readers; for the figures and descriptions, therefore, we must refer to the publications already quoted. Some doubtful specimens of dicotyledonous wood, have also been discovered in the cliffs upon the coast.

It is to be especially remarked, that all these fossil plants appear to be peculiar to the Hastings formation. They are not known to occur in the coal measures; nor in the chalk, or the deposits above that stratum; nor have any of them yet been found even in the Purbeck strata; and M. Adolphe Brongniart remarks, that the only fossils at all resembling them, are some discovered in Germany and Denmark, in strata apparently of the same epoch†.

The fossil plants of this tract must be distinguished from the remains now beneath the level of the sea, (what is usually called a submarine forest,) which are to be seen, at low water, between the White-rock and the West-cliff.—'Numerous remains of trees,' Mr. Webster states, 'there lie flat, the wood partly black, and partly of the natural colour: they are accompanied by great quantities of hazel-nuts‡.'

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* Some beautiful living specimens of the plants here referred to, may be seen in the splendid hot-houses of Messrs. Loddiges, at Hackney.

† Mantell: Tilgate, p. 57.

‡ Geol. Trans. 2nd Series, vol. ii. p. 35.

Animal Remains.

(65.) Of *Fishes*, the scales and bones of several small species are disseminated in the Weald clay. And large portions of the scaly covering of a species of *Lepisosteus*, a genus allied to *Esox*, have been found in the sand of Hastings, at Billinghurst in Western Sussex, and in the grit of Tilgate forest;—with, more rarely, the remains of three or more species of the fresh-water genus *Silurus* *.

Of the bones of *Birds*, which in the fossil state are very rare, several fragments have been found in the Tilgate-stone by Mr. Mantell, and are figured in his work. He conceives that they may have belonged to a species of *Ardea*, one of the tribe of Waders †.

(66.) Of *Reptiles*, the remains of turtles have been found in the Tilgate strata, and in those of Purbeck; the former being referable to the genera *Trionyx*, *Emys*, and *Chelonia*. But by far the most remarkable productions of this group belong to creatures of the Lizard tribe. Of these are the bones and teeth of the Plesiosaurus, a genus now found only in the fossil state;—with two species at least of Crocodile, the *C. priscus* and *C. Leptorhynchus*;—and fragments of the remains of two gigantic creatures, which require a more detailed description.

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* The *Silurus Glanis* inhabits the rivers of Europe and the East; it is the largest of our fresh-water fishes, being frequently 24 feet long, and weighing 300 pounds.—Mantell, Tilgate, p. 59.

† Tilgate, p. 81—82, and Plate viii.

(67.) *Megalosaurus*. The remains of this monstrous animal, of which the teeth and some of the bones have been found in the grit of Tilgate forest, have hitherto occurred only at that place; in the Isle of Purbeck; and in the remarkable pits of Stonesfield in Oxfordshire, where Dr. Buckland first discovered them *,—the fossils of which, though separated from the Wealden beds by a considerable mass of strata, and deposited at a period anterior to that group by a geological interval of great length, resemble those of the Wealden in several very remarkable points. No perfect skeleton of the Megalosaurus has yet been found; but, as the dimensions of one of the thigh-bones were no less than 2 feet 9 inches in length, and 10 inches in circumference in the smallest part, it was inferred by Cuvier that the creature must have exceeded 40 feet in length, with a bulk in the body equal to that of an elephant seven feet high:—and Dr. Buckland states, that an individual, a part of whose remains found, near Cuckfield in Sussex, are now in Mr. Mantell's collection, was probably nearly twice as large, and not less than from 60 to 70 feet long.

(68.) The form of the teeth, (which are in general very characteristic parts of the animal frame,) and the mode of dentition of this singular reptile, are among its chief peculiarities.

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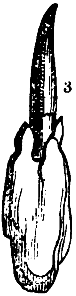
* Geol. Trans., 2nd Series, vol. i. p. 390, &c.



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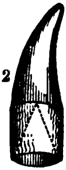

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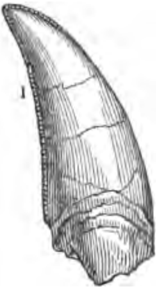

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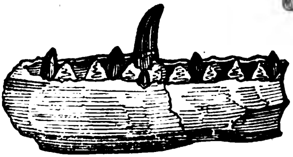

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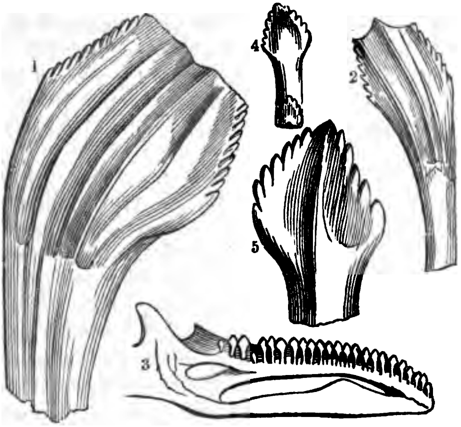
One of these teeth is here represented, of half its natural size, at fig. 1. Fig. 2 and fig. 3 are one fourth of the size of nature; the former showing by the dotted line the height to which the interior cavity of the tooth rises; the latter figure is a transverse section of the lower jaw, showing the manner in which the tooth is lodged in it. Fig. 4 is an inside view of the anterior portion of the lower jaw, on the right side, to show the mode of dentition; the scale of this figure being only one eighth of that of the original.

The figure 4 expresses tolerably well the peculiar manner in which the teeth succeed each other; and Dr. Buckland observes, that the exuberant provision in this animal for a rapid succession of young teeth, to supply the place of those which might be shed or broken, is very remarkable.

(69.) *Iguanodon.* Among the other extraordinary fossils of Tilgate Forest, Mr. Mantell in 1822 discovered some very singular teeth, which could not be identified with those of any other fossil animal at that time known, and which have never yet been found in any other place. These he suspected to belong to a reptile of the Lizard tribe, and they were sent to Cuvier, whose remarks upon them beautifully exemplified his method of considering questions in comparative anatomy.—'The teeth,' he said, 'were certainly 'new to him; they were not those of a carni-'vorous quadruped, nor of a fish.—Have we 'not here,' he adds, 'a new animal,—an herbi-'vorous reptile?—and, as among the existing ter-'restrial animals those of the greatest size are her-'bivorous, may not the largest of the reptiles of 'ancient periods, when reptiles were the only inha-'bitants of the land, have also lived on vegetable 'food?' Mr. Mantell himself, however, had the honour of pointing out the existing genus to which the monstrous possessor of these teeth most nearly approached; and he ascertained that the teeth in the still existing *Iguana* very nearly resemble those of the fossil creature.



(70.) Of these figures, copied from the plate accompanying Mr. Mantell's paper in the Philos. Transactions,—1, is a representation of one of the largest fossil teeth, the point having been worn down by mastication. 2, is a much younger tooth, in a more perfect state, but the point also slightly worn.—These figures are both of the natural size. 3, is a part of the inner surface of the upper jaw of the existing species, *Iguana tuberculata*; of the natural size. 4, a separate tooth of the same animal, magnified four times, and showing how the new tooth rises within a depression in the root of the old one. 5, the crown of one of the same teeth, still more magnified, showing more distinctly the serrature at the sides, which characterizes both the recent and the fossil species. In the mode of dentition also, the fossil creature seems to have resembled the recent Iguana; for at the base of many of the fossil teeth is a cavity for the reception of its successor, like that represented in fig. 4. But the recent Iguanas do not chew their food; they seize and gnaw the plants they live upon, with their teeth and tongue; and *bolt*, or swallow entire, what they separate. The fossil teeth, on the contrary, are all very much worn down, the whole crown of the tooth in some cases being thus worn away, evidently by the effect of mastication;—and while this process was going on, the new teeth seem to have been rising to succeed those worn out, in the cavities at the basis of the fang.

These teeth have not yet been discovered in connexion with any other part of the skeleton of the fossil animals; but very large bones have been found in great numbers near them,—which cannot be referred to any known species, but are all referable to some enormous creature of the Lizard tribe,—and which appear to have belonged to the huge possessors of the teeth. Among these is a remarkable osseous process, not very different from the lesser horn of the Rhinoceros, which probably stood upon the forehead of the extinct reptile; as a similar excrescence does, in some of the recent Iguanas. The circumference of one of the fossil thigh-bones was no less than 23 inches; and combining its dimensions with those of the teeth, some of which are twenty times as large as those of the existing Iguana, Mr. M. has computed, from a careful comparison of other parts of the skeleton, that the entire animal could not have been less than 70 feet in length.

(70*.) *New Saurian Reptile.* Since these pages have gone to the press, an account has been read by Mr. Mantell to the Geological Society †, of another nondescript reptile, from the inexhaustible repository of Tilgate Forest. The remains were found within a block or mass, more than 4½ feet by 2½, and 1½ foot in thickness; and have literally been chiselled out from the solid grit in which they were enveloped. They consist of a large part of the skeleton of the trunk of a creature, which blends the osteology of the Crocodile and the Lizard. Among the bones are many of those which supported the large scales or horny spines of the skin. But the most extraordinary parts are some enormous angular spinous bones, lying in the same direction with the vertebral column; and which, there are many reasons for supposing, may have been placed as a serrated appendage along the back of the animal. The probable length of the creature, when entire, was about 20 or 25 feet. It is obviously distinct from all the reptiles previously known; and Mr. Mantell proposes to name it, from the place of its occurrence, *Hylæosaurus*, or *Forest-Lizard**. These remarkable bones are accompanied by remains of fresh-water shells, and of the stems and leaves of plants.

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† See the Geol. Soc. Proceedings for Dec. 5th, 1832.—The author proposes to give a full account of these, and of other recent discoveries, in a new edition of his work on the Fossils of Tilgate Forest, which is very soon to appear.

(71.) *Animals without Vertebræ.* Of the lower tribes of animals, the genera included in the Wealden are few in number, but the individuals are abundant to profusion;—while, on the contrary, in the marine strata, both above and below the Wealden, the genera of the shells are numerous and varied.

(72.) *Cypris.* One of the most common fossils of the Wealden group, and the most uniformly diffused, is the case or shell of a crustaceous animalcule, *Cypris*, which comprises several species of a genus,—formerly called *Monoculus*, from its single eye,—that resides within two flat valves, like those of a bivalve shell, and of which the recent species may be seen darting through the waters of our pools and ditches. In the Weald clay some of the beds abound so much in this fossil,—chiefly the *C. Faba*,—that whole surfaces of the folia or plates, into which this clay is easily divided, are covered with them, as with small seeds. This Cypris occurs also in the Sussex marble; in the grit and sand-rock of the Hastings sands; and in the Purbeck limestone.

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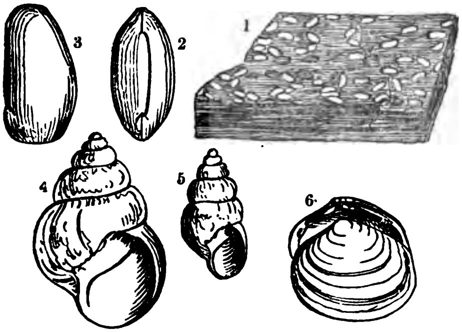
* The *Wealds*, in some older publications, are called the *Wilds* of Kent and Sussex; but the true derivation of the term is probably from the German *Wald*, a wood or forest. In this acceptation, the *Weald-* or *Wealden-Lizard* (Walden-Saurus) would be a very exact translation of the Greek name which Mr. Mantell has proposed.

Besides the *C. Faba*, two or three other fossil species of the genus have been more recently discovered; figures of which will be found, as above mentioned, in the Geological Transactions.

In the subjoined figures,—1, represents a portion of the Weald clay, thickly covered with the *Cypris Faba*; 2, a magnified view of the closed valves at the hinge; and 3, a side view of one valve.



Shells.

(73.) Of the shells of the Wealden hitherto discovered, many have been already figured in Sowerby's Mineral Conchology;—and a series of figures, including all the new species, will appear in the volume of the Geological Transactions which is now preparing for publication.

Bivalves.—*Corbula.* One species of this genus, not yet figured, has been found in the shale of Pounceford.

Tellina. One species, not figured, from the same beds, and place.

Cyclas. Of this genus, five or six species have been found in the Weald clay, Hastings-sands, and Purbeck limestone;—namely, *Cyclas major*, *C. media*, *C. membranacea*, with two or three others, not yet figured. Figure 6. represents *C. media*, of the natural size.

Unio. Of this genus, eight or nine species have been found, of which five only have been figured in the Mineral Conchology;—namely, *U. aduncus*, *U. antiquus*, *U. compressus*, *U. cordiformis*, *U. porrectus*. Casts of these species occur in great abundance throughout the grit and sand-rock of the Hastings-sands, and in the beds of sand-rock which are subordinate to the Weald clay.

Mytilus. A species, not yet described or figured, occurs in the slaty clay of Pounceford, near Battle.

Ostrea. Thin layers, composed for the greater part of oysters, occur in the different parts of the Weald-clay of the Isle of Wight; and about the middle of the Purbeck strata, is a bed twelve feet in thickness, composed almost entirely of the remains of oyster-shells. The species, however, are generally unknown and indistinct.

(74.) *Univalves.*—*Bulla*. A small species, not yet figured, in the Tilgate grit.

Melanopsis. Two species, not figured, in the shale of Pounceford.

Paludina. Of this genus, the *P. fluviorum* (4, of the figures at page 69) is the common and characteristic fossil of the Petworth or Sussex marble; and perhaps the species next to it in abundance is the *P. elongata* (fig. 5), multitudes of which occur throughout the Hastings-sands, and in the Weald clay.—Besides these, the *P. Sussexiensis* and *P. carinifera* have been figured; and there are probably two or three other species not yet published.

Neritina.—One new species, from Tilgate.

With two or more unfigured univalves, belonging to genera not well characterized.

(75.) It appears, therefore, that the total number of testaceous genera in the Wealden, hitherto determined, is not more than ten, and the total number of species not much more than thirty; while the individuals are profusely abundant. On the other hand, although the total number contained in the marine strata, both above and below the Wealden, is not greater, the genera and species are far more numerous. For in the Green-sand group only (including the upper and lower green-sands and the gault,) the genera of invertebrated animals in Sussex are forty-nine, and the species eighty-six; according to the excellent catalogue of Mr. Mantell. This fact alone is characteristic of the productions of fresh water: and even of the few marine species which the Wealden affords, some, as the oyster and the muscle, are well known to inhabit estuaries within the range of fresh water.

(76.) 'In concluding this description,' Mr.

Mantell says, at the close of his account of the organic remains of Tilgate Forest*, 'it may be 'remarked, that the vast preponderance of the 'land and fresh-water exuviæ over those of ma'rine origin, observable in these strata, warrants 'the conclusion, that the Hastings [Wealden] 'beds were formed by a very different agent from 'that which effected the deposition of the Port'land limestone below, and the sands and chalk 'above them.

'Whether the land of that time were an island, 'or a continent, may not be determined; but that 'it was diversified by hill and valley, and enjoyed 'a climate of a higher temperature than any part 'of modern Europe, is more than probable. Se'veral kinds of ferns appear to have constituted 'the immediate vegetable clothing of the soil. 'But the loftier vegetables were so entirely di'stinct from any that are now known to exist in 'European countries, that we seek in vain for 'anything at all analogous, without the tropics. 'The forests of Clathraria and Endogenitæ (the 'stems of which, like some of the recent ar'borescent ferns, probably attained a height of 'thirty or forty feet,) must have borne a much 'greater resemblance to those of tropical regions, 'than to any that now occur in temperate climates. 'Turtles of various kinds must have been seen 'on the banks of its rivers or lakes, and groups 'of enormous crocodiles, basking in the fens and 'shallows. The gigantic Megalosaurus, and yet

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* P. 82.

'more gigantic Iguanodon,—to which, the groves 'of palms and arborescent ferns would be mere 'beds of reeds, must have been of such prodigious 'magnitude, that the existing animal creation 'presents us with no fit objects of comparison. 'Imagine an animal of the Lizard tribe, three or 'four times as large as the largest Crocodile,— 'having jaws, with teeth equal in size to the in'cisors of the Rhinoceros, and crested with horns; 'such a creature must have been the Iguanodon! 'Nor were the inhabitants of the waters much less 'wonderful;—witness the Plesiosaurus, which 'only required wings to be a flying dragon; the 'fishes resembling Siluri, Balistæ, &c. &c.'

PORTLAND STRATA.

(77.) The beds of this formation do not anywhere occur within the tract described in the preceding pages: but the facts connected with the junction of the fresh-water group of strata with the marine beds beneath, upon the confines of the Purbeck and the Portland groups, are intimately connected with the probable history of their deposition; and are too remarkable to be passed over:—although the story can hardly be made intelligible or impressive without entering into some detail.

(78.) The following is the succession of the strata in the upper part of the Isle of Portland, described by Mr. Webster[*], from a section in one of the quarries at the north end of the island, which was open to the day ; the names marked with inverted commas being those in use among the quarrymen :—

				Thickness.	
				Ft.	*In.*
		1.	*Soil ;* seldom exceeding a foot in depth.	1	0
Purbeck Formation.	*Fresh-water.*	2.	"*Slate ;*"—a series of thin beds of compact limestone ; without fossils . .	3	7
		3.	"*Ash ;*" — Calcareous stone, softer, and of lighter colours than 2.	2	6
		4.	*A Slaty bed ;*	1	0
		5.	"*Soft Burr ;*"	1	6
		6.	"*Dirt Bed ;*"—an earthy bed, dark brown, containing much earthy lignite, and including the fossil wood of Portland	1	0
	Doubtful.	7.	"*Top-cap ;*"—in part compact ; in other places containing compact portions imbedded in a softer rock ; in others, slightly cellular. No fossils. The stone has the aspect of fresh-water limestone	10	0
		8.	"*Skull-cap ;*"—compact cellular limestone	3	0
Portland Formation.	*Marine.*	9.	"*Chert ;*"—a layer of flints, including oolitic grains ; with marine fossils. .	0	6
		10.	"*Roach ;*"—The fossils of this bed are all marine. . . . . About	15	0
		11.	"*Rubbly-Bed ;*"—limestone, abounding in casts of marine shells.		
		12.	Another bed of *limestone,* like No. 10.	6	0
		13.	*Stone and Flint* ; the lowest beds of this group.	30	0

Below is Sand; and then, the *Kimmeridge-clay.*

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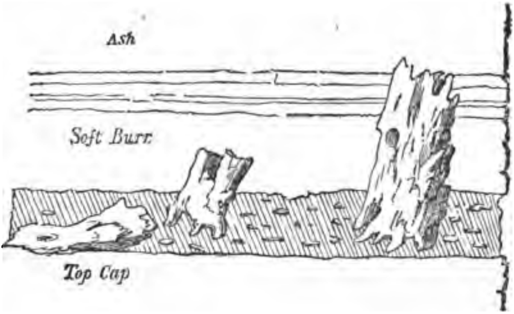
[*] Geol. Trans., 2nd Series, vol. ii. p. 41, &c.

(79.) 'The *Soft Burr,*' No. 5 of this list, Mr. Webster mentions, 'stands upon a bed, about a 'foot in thickness, of a dark brown substance, 'containing much earthy lignite. This latter bed 'is very remarkable, and extends through the 'north end of the Isle of Portland; I even found 'some traces of it in the coves at the west end 'of Purbeck. It is called by the quarrymen the '"*Dirt-bed.*" In it are found considerable numbers of the fossil trunks of trees of the Dicotyledonous class; which are from one to two 'feet in diameter, the part originally wood being 'now converted into silex.



'I saw one of these trunks standing erect; and 'the workmen informed me they were frequently 'found in that position: its lower part was thick'est; and, being divided, it gave the idea of roots. 'Its upper part penetrated through the "*Soft* '*Burr,*" and terminated in the "*Ash.*" This is the 'fossil wood which is so often brought from the 'Isle of Portland[*]; and upon the most careful 'inquiry and examination, I could not discover 'that it was found in the oolite itself, or in any 'other part of the series. In this earthy bed are 'also many stones, evidently water-worn, which I 'afterwards ascertained to belong to the lower 'part of the Portland series.'

(80.) Now it is very remarkable, that a stratum, containing bituminous matter, and agreeing with Mr. Webster's account of the earthy bed above described, occurs,—in precisely the same situation with respect to the Purbeck and Portland formations,—in the cliffs of the Boulonnois, upon the opposite coast of France[†]; and Dr. Fitton, who mentions its occurrence, has since found a similar bed, and in a corresponding place,—just at the junction of strata which include fresh-water shells, with the equivalent of Portland stone, in Buckinghamshire and in the Vale of Wardour[‡]. In this bituminous bed, silicified wood is found, in fragments, all along the shore, from Boulogne to Cape Gris-Nez. So uniform, indeed, is its occurrence there, that a collector at Boulogne, to whom this bituminous bed was mentioned, observed immediately, that he was well acquainted with it, and that whenever he wished to obtain specimens of the petrified wood, he went to that stratum, and was sure to find them. In the calcareous strata, likewise, over this bituminous matter, shells, belonging to fresh-water genera, have been found, on the coast of the Boulonnois, as well as in England. It appears, therefore, that the presence of this remarkable bed is co-extensive with the contact of the Portland and the Purbeck strata, so far as they have hitherto been examined.

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[*] In some of these petrified trees, Mr. Brown has recognised the structure of coniferous wood.—See Geol. Trans., 2nd Series, ii. p. 396.

[†] Proceedings of Geol. Soc., Dec. 1826, pp. 8 and 9;—and MS. notes.

[‡] Ibid., June, 1827,—and MSS.

(81.) Thus stood the question, when Dr. Buckland published, in 1828, an account of some very curious fossils from the Isle of Portland *,—the petrified remains of plants allied to the natural family of Cycadeæ, and resembling the existing genera Zamia and Cycas, though still distinct from both; the differences being sufficient, in the opinion of Mr. Brown, to place them in a *new* family, to which the name of Cycadeoideæ was given in Dr. Buckland's paper †. These bodies are now converted into silex; their substance varying from a coarse granular chert to imperfect calcedony; and everything seems to favour the supposition, that the plants thus petrified, like those of the analogous recent genera, were the inhabitants of a climate much warmer than that of England at present. But the inquiry did not end here; for Dr. Buckland and Mr. De la Beche having visited the Isle of Portland, since the publication of the last-mentioned paper, and examined the beds immediately above the oolitic strata containing marine remains, ascertained that the Cycadeoideæ occur there, in the bed of bituminous clay above mentioned, along with the trunks of Dicotyledonous trees. 'Many stumps of trees,' they state, 'remain erect, with their roots at-'tached to the black soil *in which they grew*, 'and their upper part in the limestone.' And they thence infer, 'that *the surface of the subjacent 'Portland stone was for some time dry land, and 'covered with a forest; and probably in a climate 'such as to admit the growth of the modern Zamia 'and Cycas*[*]!'

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* Geol. Trans., 2nd Series, vol. ii. p. 395, &c.

† M. Adolphe Brongniart, who afterwards described the specimens from this place, has chosen the name *Mantellia* for the new genus to which he assigns them.

(82.) Whatever, therefore, be the characters of the strata, or whatever the formation above this bituminous bed of Portland, there seems to be no reason to doubt that it was the soil in which the trees and Cycadeous plants grew; and that it continued so for a sufficient time to produce and sustain great trees, before the deposition of any of the incumbent strata.—One of the most interesting facts, unquestionably, in the Geology of

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[*] See the abstract of the paper, from whence this passage is taken, Geol. Soc. Proceedings, April 1830, pp. 218, 219; and Phil. Mag. and Annals, vol.vii. p. 454. The details will appear in the memoirs of Dr. Buckland and Mr. De la Beche, now in the press, for the IVth volume of the Geol. Transactions.

England, marking distinctly one epoch in the series of revolutions to which its strata have been exposed.

(83.) We have thus gone through the list of the strata connected with the tract in the vicinity of Hastings, from the Chalk down to the Portland stone; and the general inferences from what has been mentioned are so obvious, that a statement of them will be more like a repetition of the facts themselves, than a train of laborious reasoning.

1. The Portland limestone, No. 8, containing the remains of none but marine animals and shells, must have been deposited beneath salt water. The species of these shells, it is true, no longer exist; but of the genera, no one living species is known to inhabit fresh water;—all are marine.

2. The mass of the Portland strata must have been raised from the waves, and must have continued to be dry land, for a time sufficient for the growth of the trees and Cycadeæ, whose remains are still found upon their surface.

3. But above the soil affording these trees and plants, we now find beds of slaty limestone,—in the Isle of Portland, in Wilts and Buckinghamshire: and, in the Isle of Purbeck, besides such slaty beds, a considerable thickness of compact limestone, full of shells, is so connected with the strata of the Hastings-sands and Weald-clay, as to prove that the whole were deposited continuously. To admit of this, it is obvious, that,—*after* the plants and trees had grown and flourished on the

top of the Portland beds, the whole surface of what then was land must have been submerged, to such a depth, as to allow of the accumulation over it of all the Wealden group, which cannot be estimated at less than 700 feet in thickness. And this submersion, to all appearance, whether sudden, or, as seems most probable, gradual and slow, was effected tranquilly; for in many cases the trunks of the petrified trees retain their upright position, within the substance of the calcareous strata, by which they are now surrounded.

4. The fossils of the beds, thus deposited above the vegetable soil of Portland, are all such as might have been produced in fresh water communicating with the sea. In the waters of this estuary, and of the river of which it may have been the mouth, the aquatic animals must have been nourished, whose remains we now find so profusely throughout the strata of the Wealden. But dry land, also, must have been near at hand; —'In fact, its existence at no great distance 'seems clearly indicated, by the remains of the ve'getables and amphibia of Tilgate Forest: some 'of the former must have grown on the borders of 'a river or lake; and the habits of the recent 'species most nearly related to the latter, war'rant a similar conclusion, since they are well 'known to frequent the rivers and marshy tracts 'of tropical regions, in the sands and banks of 'which they deposit their eggs *.'

5. The group thus accumulated is distinguished

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* Mantell,—Sussex, p. 57.

by many peculiar circumstances. Among these are,—the marked difference in the character of the fossils from those of the marine strata, both below it and above;—the novelty of the fossils themselves, many of them not having hitherto been found in any other situation;—the proofs which they afford of a great subsequent change in the climate of this part of the globe;—the limited space which the formation appears to have occupied,—and its gradual diminution in thickness towards its borders,—so far at least as it has yet been possible to trace the subterranean boundaries of a group, of which, unfortunately, such small portions are disclosed. All these facts, it will be observed, accord with the hypothesis of its origin in fresh water communicating with the sea.

6. After the depression of the surface last mentioned,—to a depth not yet beyond the access of deposits from fresh water,—next comes a farther depression of the surface, still covered with water, and along with it most probably of the land from which the fresh water was supplied,—to such a depth that it became accessible to sea water alone: for, above the Wealden group, we find a numerous succession of strata,—the greensands, the gault, and the chalk,—abounding in fossils, *not one of them belonging to any genus of which the existing species inhabit fresh water*;—and, it may be added—(the observation, indeed, applies to all the strata we have mentioned)—

not a single one of which belongs to any species at present known to exist in any recent sea!

7. The duration of this last epoch of submersion, we are not enabled to measure, except by the mass of the strata accumulated during its progress:—a thickness, at the lowest estimate, of not less than 1200 feet. But, though the contrast of the fossils of the Wealden, and of these incumbent beds, is sudden and complete,—there is no mark of violence at their junction; and the change, for anything that appears to the contrary, may have been effected, simply by slow and gradual depression to a greater depth than before, beneath the general level of the sea.

8. Operations of a different character now succeed. The strata we have mentioned have all the characters of tranquil deposition; and they must have been originally horizontal, or very slightly inclined. But they are now found to be elevated uniformly, though at a small angle, towards the west of north; the whole of the existing land in the east of England having been, to all appearance continuously, uplifted in that direction. And, besides this more extensive raising, the entire mass of the strata has been in some places broken through, by partial and more violent heavings; which seem to have acted in continuous or parallel lines, directed in a general view from east to west. In the Isle of Wight, the chalk beds which form the eastern ridge of the island,—and along the Dorsetshire coast, all the strata, from the chalk

down to the Portland stone,—are nearly vertical. In the chalk ridge, on the west of Guildford in Surrey, the strata rise at an angle not much less than 45°; and within the ridge of the Hastings-sands, not only inclined portions, but distinct fractures of the strata, are very frequent. The case, in short, supposed in Section (9), and which the figures at pages 7 and 8 are intended to illustrate, gives nearly a correct representation of what actually occurs in nature.

Whether these fractures and upheavings took place entirely beneath the sea, or after the strata had been in part, or wholly, raised above its surface,—at once, or at distant epochs,—we have no facts that enable us to decide. It is, indeed, not impossible, that the very act of rending the strata, may have itself effected their protrusion from beneath the waves. Nor can we tell how long these operations were going on; though the appearance of violence in many places, seems to prove that they were not so gradual and tranquil, as some geologists have supposed.

9. Lastly:—Since the disclosure of the land thus broken up, the surface appears to have been comparatively undisturbed:—but it has been cut into by torrents,—worn away by the incessant action of rains and frost,—and, finally, its asperities softened down by the effects of vegetation;—and thus it has been gradually moulded into the forms which we now behold.

(84.) If we have succeeded in explaining the facts referred to in the preceding pages, there will now be no difficulty in answering the question proposed by Cuvier, after treating of the wonders which his own researches in comparative anatomy had brought to light.—'At what period 'was it, and under what circumstances, that 'Turtles and gigantic Crocodiles lived in our latitudes, and were shaded by forests of palms and 'arborescent ferns?'*—We cannot, indeed, reply to this question by reference to any measure of time connected with the history of man,—nor tell how many years or ages may have passed, silent and uncounted, during the wide interval by which the present time is separated from that remote period; but we can state, almost with certainty, some of the principal events in the series of geological occurrences which marked their progress, and specify at least one epoch, during which the wonders which Cuvier refers to may have coexisted. If we are not deceived, our readers will themselves be now enabled to anticipate the reply of the geologist; and to pronounce,—that, along with the Turtles and the Crocodiles, were the Iguanodon, the Megalosaurus, the Plesiosaurus, and other enormous reptiles of the Lizard tribe; and all the other strange and curious animals and plants, whose remains are found within the strata of the Wealden. The period of their existence was, unquestionably, prior to the deposition of the green-sands and the chalk; and they must have lived and died during the interval that followed the submersion of the land which bore upon its surface the Cycases and the trees of Portland; when the Ganges and the Niger of former continents sent down their waters to the seas which then existed;—when the Cyprises, the Cyclases, Unios, and Paludinas, of species now unknown, lived in the rivers; and oysters, also of species which exist no longer, inhabited the shallows at their junction with the sea.

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* Cuvier: quoted by Mantell,—Sussex, p. 57.

(85.) There is proof, therefore, in what has been stated, even in this little volume, from an examination of the vicinity of Hastings, of most extraordinary revolutions in the state of the earth's surface;—of alterations in its form, its climate,—in the structure and appearance of the animals and plants by which it has been inhabited. If we had pursued these inquiries, and traced the history of other formations, we should have had before us evidence of changes not less striking in the former surfaces of the globe, at periods both antecedent and subsequent to the deposition of the strata which have been just described. Decisive evidence of this description is to be found in the beds below those of the Isle of Portland; and, above the chalk, the proofs of repeated submersion and disclosure are not less clear. The fact, indeed, of great and frequent alteration in the relative level of the sea and land, is so well established, that the only remaining questions regard the *mode* in which these alterations have been effected,

—whether by elevation of the land itself, or subsidence in the level of the sea?—and the nature of the force which has produced them? The discussions upon these points have been some of the most interesting in geology; but they would lead us far beyond the limits of the present publication. It will be sufficient to say, that the evidence in proof of great and frequent movements of the land itself,—both by protrusion and subsidence,—and of the connexion of these movements with the operations of volcanoes, is so various and so strong,—derived from so many different quarters on the surface of the globe, and every day so much extended by recent inquiry,—as almost to demonstrate that these have been the causes by which those great revolutions were effected;—and that, although the action of the inward forces which protrude the land, has varied greatly in different countries and at different periods, they are now, and ever have been, incessantly at work in operating present change, and preparing the way for future alteration, in the exterior of the globe. But for the detail of the proofs upon this great and leading point in the theory of the earth, we must refer to various publications of modern date; and, most especially, to the writings of Dr. Hutton and Mr. Playfair, and the more recent extension and beautiful illustration of their doctrines, by Mr. Lyell.

(86.) These, then, are some of the results to which we are conducted by inquiries such as we have been engaged in. They are not, like the visions of the old cosmogonists, the creations of fancy, but sound and legitimate consequences, flowing naturally and inevitably from the plainest evidence,—from facts obtained with great labour, and scrupulously weighed. It is this exercise of the intellect, to which geological researches so directly lead, that constitutes their great charm and attraction :—it lightens and ennobles the drudgery of detail, and gives to the pursuit the dignity by which it is eminently distinguished as a department of natural science.

LIST OF HEIGHTS.

THE heights of the following places, above the mean level of the sea, have been calculated, barometrically, from observations with excellent instruments*.

At Hastings, the Spring-tides ebb and flow . 21 feet.
——————— Neap-tides, 13 to 15; mean 14 feet.

KENT.

	Feet.
South Foreland,—Lower Light-house	267
(Dover-Castle Hill, from Ordnance Survey, 469 ft.)	
Shakspeare's Cliff	341
Signal House on the Cliff, between Dover and Folkstone	455
Top of Chalk Cliff, near Folkstone	573
Top of Folkstone Hill (Trigonometric station)	576
(The same, from the Ordnance Survey, 575 ft.)	
Top of Cliff of Gault, Copt Point	132

SUSSEX.

Fairlight, Church Porch	536·5
———— Signal House	477·5
———— Down (Trigonometric station)	582·5
(The same, from Ordnance Survey, 599 feet.)	

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* MS. papers.

	Feet.
Top of Cliff, at the Haddocks	215
The Lovers' Seat	339
Highest point of Hill, between the Covehurst and Eaglesbourne	389
Hastings,—Drawing-room Floor, No. 10, Croft	109
——— Top of East Hill	342
——— Top of East Cliff	248
——— Castle Hill (West Cliff), highest point	260

Beachy Head,—Signal House	549
(The same?, by Ordnance Survey, 564 feet.)	
——— highest point of the Cliff	534
Highest point of Cliff, west of Castle Hill, Newhaven	199
Cliff Top, Rottingdean	119
Signal House, on the race-ground, near Brighton	397

The following heights, in the interior of Sussex, are given in Smith's Section (1819), probably from the Ordnance Survey.

	Feet.
Eridge Park	659
Crowborough Beacon (Forest Ridge)	804
Brightling Down	646
Ditchling Beacon (South Downs)	858

LIST OF PUBLICATIONS.

THE following is a list of the principal publications connected with the geology of the tract described in the preceding pages, in the order of their appearance.

1743.

Packe, Christopher, M.D. ‘ΑΓΚΟΓΡΑΦΙΑ, *sive Convallium Descriptio*, &c., as an explanation of a new ‘Philosophico-chorographical Chart of East Kent.’ 4to, pp. 110.

——————— ‘A new Chorographical ‘Chart of East Kent, invented and delineated by ‘Christopher Packe, M.D.’ A Map of 32 miles around Canterbury, on a scale of $1\frac{6}{10}$ of an inch to a mile.

1816.

Webster, Thomas. ‘Observations on the Strata of the ‘Isle of Wight, and their continuation in the adjacent ‘parts of Dorsetshire.’ (In Sir H. Englefield's description of the Island.) 4to. With numerous Plates.

1819.

Smith, William. ‘Geological Section of the Strata in ‘Surrey and Sussex, from London to Brighton.’ A coloured Plate.

1821.

Phillips, William. ‘Remarks on the Chalk Cliffs in the ‘neighbourhood of Dover, and on the blue Marl co‘vering the Greensand near Folkstone.’ (Read Jan. 1818.)—Geological Transactions, vol. v. p. 16, &c.

1822.

Mantell, Gideon. 'The Fossils of the South Downs, or 'Illustrations of the Geology of Sussex.' 4to, pp. 320. With numerous Plates.

Conybeare, Rev. Wm., and Phillips, W. 'Outlines of 'the Geology of England and Wales.' 12mo.

Sedgwick, Rev. Adam. 'On the Geology of the Isle 'of Wight.'—Ann. of Phil., New Series, May 1822, vol. ii. p. 329, &c.

1824.

Buckland, Rev. William. 'Notice on the Megalo-'saurus, or great Fossil Lizard of Stonesfield.' (Read Feb. 20th.)—Geol. Trans., 2nd Series, vol. i. p. 390.

Fitton, William Henry, M.D. Abstract of a paper, entitled, 'Notes on Part of the opposite Coasts of the 'English Channel, from Dover to Brighton, and from 'Calais to Treport.' (Read June 18th.)—Ann. of Phil., N.S., vol. viii. p. 67.

———————————— 'Inquiries respecting 'the Geological Relations of the Beds between the 'Chalk and the Purbeck Limestone in the South-east 'of England.'—Ann. of Phil., N.S., (Nov. 1824,) vol. viii. p. 365, &c.

———————————— 'Additions to the pre-'ceding Paper.' Ibid. (Dec.) p. 458, &c.

Webster, Thomas. Abstract of a Paper, entitled, 'Ob-'servations on a Comparison between the Beds below 'the Chalk, in the Isle of Wight, and in the counties 'of Surrey, Sussex, and Kent.' (Read Nov. 5th.)—Ann. of Phil., vol. viii. p. 465.

1825.

———————— 'Reply to Dr. Fitton's Paper, in the 'Annals of Philosophy for Nov. 1824.'—Ann. of Phil., N.S., (Jan. 1825,) vol. ix. p. 33.

Mantell, Gideon. 'Notice on the Iguanodon, a newly 'discovered fossil herbivorous Reptile, from the 'Sandstone of Tilgate Forest, in Sussex.' (Read Feb. 10th.)—Philosophical Transactions, 1825, p. 179.

1826.

—————— 'On the Iron-sand Formation of 'Sussex.' (Read June 14th, 1822.)—Geol. Trans., 2nd Series, vol. ii. p. 131.

Murchison, R. I. 'Geological Sketch of the North-'western extremity of Sussex, and the adjoining parts 'of Hants and Surrey.' (Read Dec. 16th, 1825.) —Geol. Trans., 2nd Series, vol. ii. p. 97.

Buckland, Rev. William. 'On the Formation of the 'Valley of Kingclere, and other Valleys, by the elevation of the Strata that inclose them, &c.' (Read Feb. 8th, 1825.)—Geol. Trans., 2nd Series, vol. ii. p. 119.

Webster, Thomas. 'Observations on the Strata of Hastings, Sussex.' (Read June 4th, 1824.)—Geol. Trans., 2nd Series, vol. ii. p. 31.

—————— 'Observations on the Purbeck and 'Portland Beds.' (Read Nov. 19th, 1824.)—Ibid. p. 37.

1827.

De Basterot, B. 'Extract of a Letter, On the Vicinity 'of Folkstone.' (Read Dec. 1st, 1826.)—Geol. Trans., 2nd Series, vol. ii. p. 334.

Fitton, Wm. Henry, M.D. Abstract of a Paper, entitled, 'Additional Notes on Part of the opposite Coasts of 'France and England; including some account of the 'Lower Boulonnois.' (Read Dec. 1st and 15th, 1826.)—Geol. Soc. Proceedings, 1826-7, p. 6, &c.; and Phil. Mag. and Annals, vol. i. p. 136.

Mantell, Gideon. 'Illustrations of the Geology of Sussex, &c., with figures and descriptions of the Fossils 'of *Tilgate Forest*.' 4to, pp. 92. With numerous Plates.

Martin, *P. I.* 'On the Geology of the Vicinity of 'Pulborough.' (Read March 16th, 1827.)—Geol. Soc. Proceedings, 1827, p. 19; and Phil. Mag. and Annals, vol. i. p. 388.

Mantell, *Gideon*. Abstract of 'A Notice accompanying 'some specimens from the Hastings-sand formation.' (Read June 5th, 1827.)—Geol. Soc. Proceedings, 1826-7, p. 10; and Phil. Mag. and Annals, vol. i. p. 140.

Fitton, *Wm. Henry*, *M.D.* Abstract of a paper, entitled, 'Remarks on some of the Strata between the Chalk 'and the Kimmeridge Clay, in the South-east of England.' (Read June 15th, 1827.)—Geol. Soc. Proceedings, 1826-7, p. 26; and Phil. Mag. and Annals, vol. ii. p. 220.

1828.

Martin, *P. I.* 'A Geological Memoir on a Part of 'Western Sussex; with some Observations upon 'Chalk Basins, the Weald Denudations, and Outliers 'by Protrusion.' 4to, with a Table, Map, and Sections. pp. 100.

Mantell, *Gideon*. 'A Tabular Arrangement of the Organic Remains of the County of Sussex.' (Read June 6th, 1828.)—Geol. Trans., 2nd Series, vol. iii. p. 201.

Buckland, *Rev. William*. 'On the Cycadeoideæ, a family of Fossil Plants, found in the Oolite Quarries 'of the Island of Portland.' (Read June 6th, 1828.) —Geol. Trans., 2nd Series, vol. iii. p. 395.

1829.

Martin, *P. I.* 'Observations on the Anticlinal Line 'of the London and Hampshire Basins, &c.'—Phil. Mag. and Annals, (Feb. 1829,) vol. v. p. 111.

Buckland, Rev. William. Abstract of a paper 'On the 'discovery of the Bones of the Iguanodon, and other 'large Reptiles, in the Isle of Wight and Purbeck.' (Read Dec. 4th 1829.)—Geol. Soc. Proceedings, 1829-30, p. 159; and Phil. Mag. and Annals, N.S. vol. vii. p. 54.

1830.

Buckland, Rev. William, and De la Beche, H. T., Esq. Abstract of a paper 'On the Geology of Weymouth, 'and the neighbouring Coasts of Dorsetshire.' (Read April 1830.)—Geol. Soc. Proceedings, 1829-30, p. 218; and Phil. Mag. and Annals, N.S., vol. vii. p. 454.

1832.

De la Beche, H. T., Esq. 'A Geological Manual.' 2nd Edition.—[Wealden Rocks; p. 302 to 310.]

Mantell, Gideon. 'A Notice on the Geology of Tunbridge Wells.' (From Britton's Topographical Sketches of Tunbridge Wells.) 8vo, pp. 12.

———————— 'Observations on the Remains of the 'Iguanodon, and other Fossil Reptiles of the Strata 'of Tilgate Forest. (Read Dec. 5th.)—Geol. Soc. Proceedings, No. 28.

THE END.

Printed by Richard Taylor, Red Lion Court, Fleet Street.

Sussex:

Fig. 1.

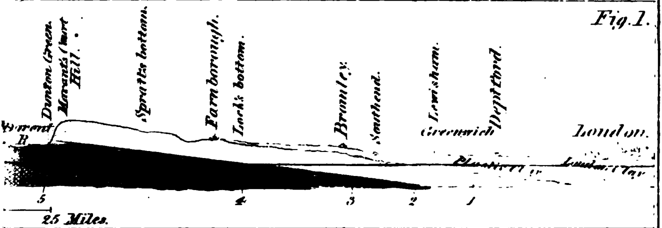


Fig. 2.

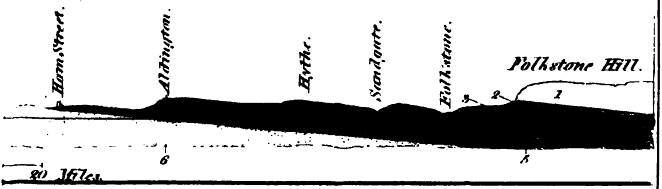


Fig. 3.

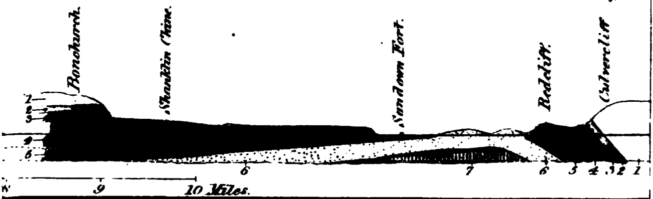
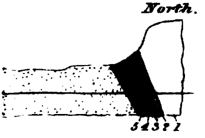


Fig. 4.



List of Strata.

		Thickness in feet.
1	Chalk	700.
2	Upper Greensand	100.
3	Gault	150.
4	Lower Greensand	250.
5	Wealden: Weald Clay	300.
6	Wealden: Hastings Sands	400.
7	Wealden: Purbeck Beds	250.
8	Portland Stone & Sands	120.